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WAR MACHINE

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Ground-launched Cruise in Action

The Strategic Missile Balance

Armed Forces
of the World:
Sweden

This issue: A guide to the world's surface to surface missiles

WAR MACHINE

Volume 1 **Issue 2**

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Armed Forces of the World

Sweden iii

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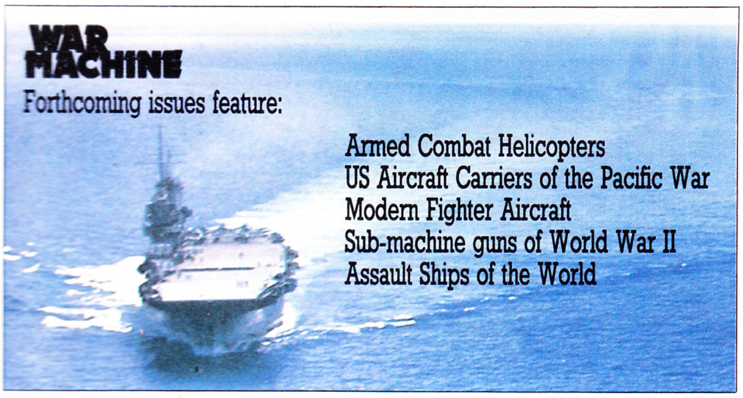

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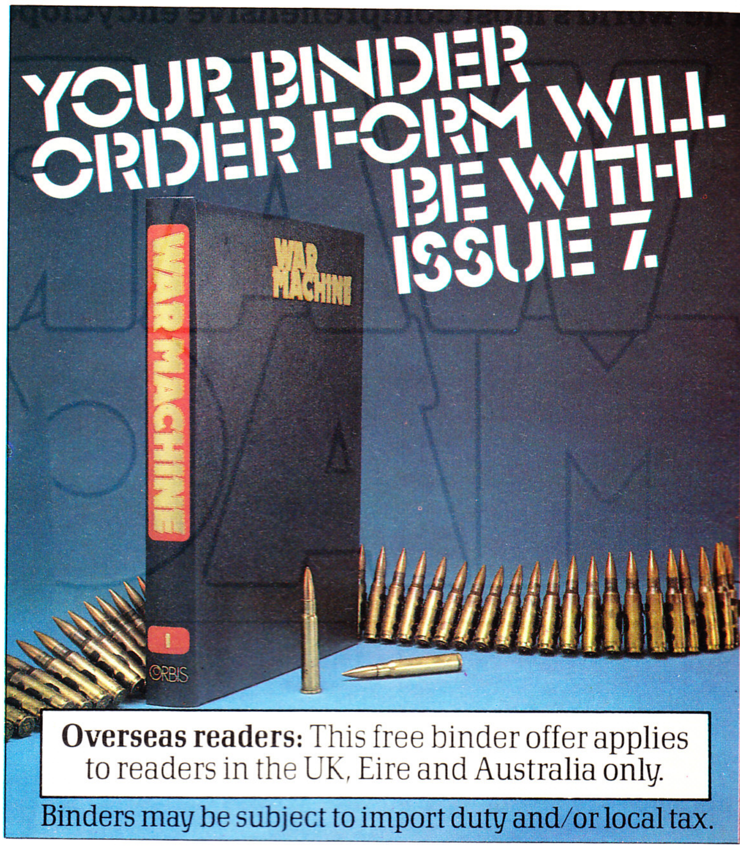

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Surface to Surface Missiles

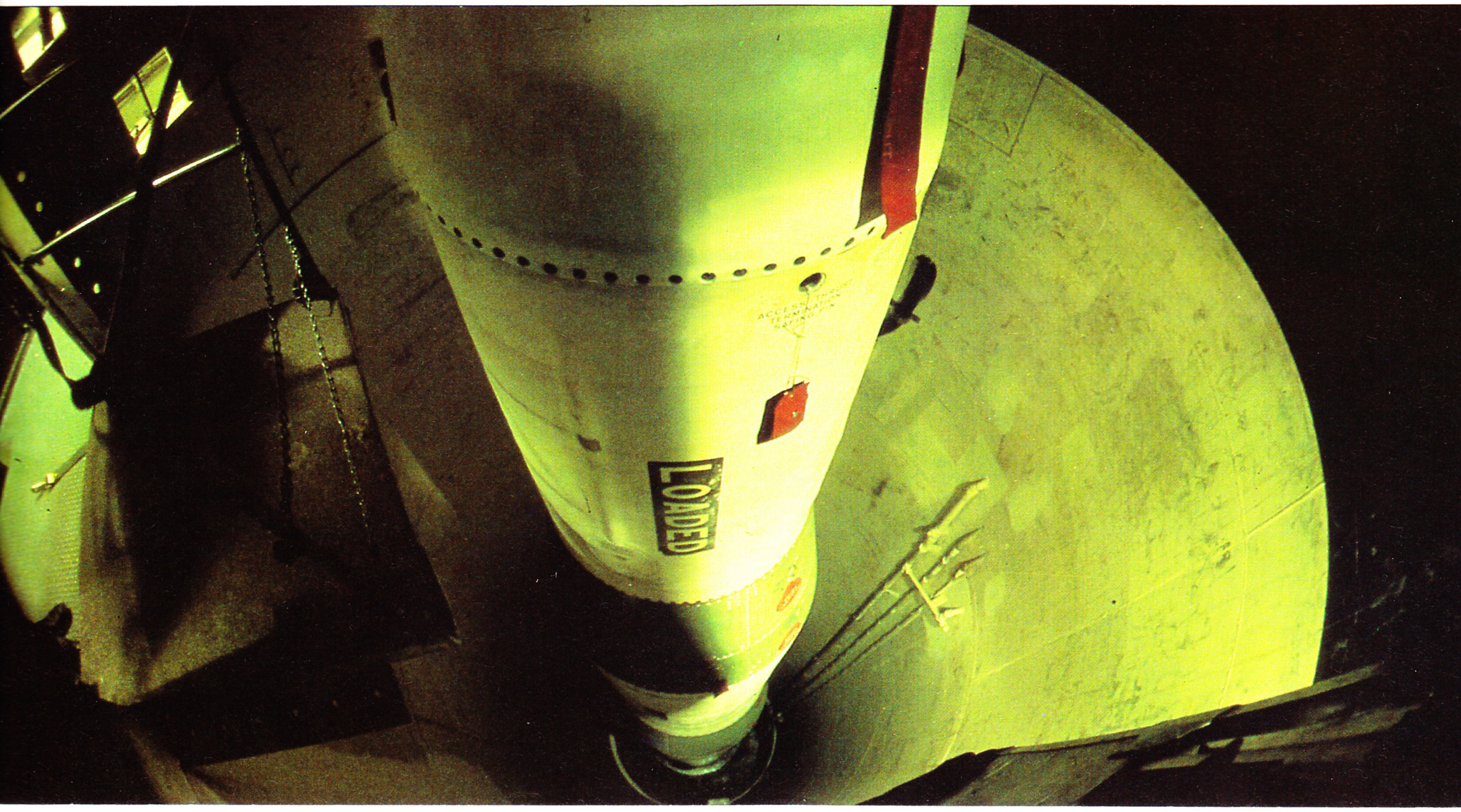
Ever since the dropping of the atom bombs on Japan in 1945 the defence of the big powers has been based on the mutual fear of nuclear warfare, and missile forces have been the main agents of those in command. Deterrence seemed absolute. but the emergence of smaller mobile battlefield nuclear weapons has destabilized the once-simple equation. Do these weapons maintain our security or produce a dangerous and potentially deadly insecurity?

Lance is the only battlefield guided missile of NATO armies, and it is a relatively small weapon. At launch the dense smoke from its on-board gas generator is expelled through tangential ports to spin the missile, adding stability. One of Lance's good features is that it can be fitted with a variety of different warheads, including nuclear.

Land-based missile systems are usually classed as strategic, theatre, or tactical. Strategic normally refers to those missiles which have intercontinental ranges (more than 3,350 miles/5400 km), and as such are termed Inter-Continental Ballistic Missiles (ICBMs). Only three countries possess this class of missile, the USA, the USSR and China. In the case of the first two, each deploys over 1,000 ICBMs of various types that are divided into either the heavy or lightweight variants depending on their size, throw-weight and performance capabilities. China has only deployed 14 ICBMs to date, and is involved in a active research and development programme to increase this force level in order to provide a credible deterrent against the USSR.

Theatre area missiles are those missiles that have ranges restricted to specific geographical areas, such as West and East Europe. They can be called either Medium-Range Ballistic Missiles (MRBMs) with ranges between 700 and 1,725 miles (1125 and 2775 km) or Intermediate-Range Ballistic Missiles (IRBMs) with ranges between 1,725 and 3,350 miles (2775 and 5400 km). The USA did at one time deploy IRBMs, but withdrew them as her ICBM programmes matured. The greatest operator of the two systems is the USSR, which created a peak force of some 700 missiles in the 1960s for use against possible targets in Europe, the Middle East and China. The USSR has also pioneered the use of the mobile IRBM system. The second major operator is China with some 100 MRBMs and IRBMs currently deployed against Soviet targets. France maintains a small 18-round IRBM force as its land-based deterrent force contribution.

The tactical missiles are classed as those missiles with ranges of less than 700 miles (1125 km). These systems can be divided into two groups: those which can be used in the direct-support role in the vicinity of front-line troops (and as such are known as battlefield support missiles), and those which are capable of striking targets out to their maximum allowable range under the system classification (and as such are usually termed Short-Range Ballistic Missiles, or SRBMs). The SRBM is confined to the inventories of the USA, USSR and Libya, whilst battlefield-support missiles can be found in practically all the NATO and Warsaw Pact armies, and also in the armies of the two superpowers' most important client states.



Looking down into a Minuteman ICBM silo. The silo is extremely strongly built to withstand nuclear attack, but large enough for the giant flame from the first-stage motor to escape past the missile without damaging it. Minuteman is over 20 years old and a very small missile compared with the much more numerous Soviet ICBMs.

The Land Based Strategic Missile Balance

A Minuteman ICBM rockets up from its silo in a practice launch from Vandenberg Air Force Base, California. Housing in silos was supposed to protect US missiles from a Soviet first strike, but improvements in Russian missile warhead yield and accuracy have eroded that security, creating anxiety in the minds of the American defence establishment. This anxiety has now manifested itself in the production of the MX, but US politicians seem to be hopelessly confused as to its adoption and method of deployment. The latest scheme is to house them in the supposedly vulnerable Minuteman silos!

The current strategic weapons of the two major superpowers are deployed on three types of delivery system that are collectively known as the Triad. These systems are the land-based ICBM, the long-range bomber carrying the gravity bomb and/or nuclear missile, and the missile-carrying submarine. In each case there are two essential factors to be considered in assessing the value to the Triad of the delivery platform. They are penetration to the target, and survivability. In the first case the need is for the majority of the attacking systems to avoid destruction by the enemy defences, and in the second case the need is for a significant percentage of systems to survive a pre-emptive strike before their own launch. It is this second factor which is causing the most concern at present to US strategic warfare planners.

The US Minuteman and Titan II ICBM force is housed in specially hardened underground missile silos built to survive nuclear blast over-pressures of between (35 and up to 70 kg/cm^2 (500 and up to 10,000 lb/sq in). The silos are also proofed to provide protection against the radiation and other electro-magnetic waves that originate from the explosions. The fixed-location silo allows for better missile guidance accuracy as the missile will be fired from a pre-surveyed site to a precisely known target location, thus ensuring that the onboard inertial navigation system has exact sets of co-ordinates to use in its calculations. However, when the opposing side increases its missile performance to the level where a combination of warhead yield and accuracy overcomes the advantage of the silo anti-blast hardening features then the fixed-location basing concept makes the ICBM inherently vulnerable. The Americans have now conceded that this is the case with their ICBM forces as the present Soviet force of SS-18 Model 4 and SS-19 Model 3 ICBMs can destroy the majority of the US missiles and associated command, control and communications centres in a first-strike attack. This, coupled with the contingency planning the Soviets have for reloading launch silos that have already been used to fire an initial round of SS-17s and SS-18s, and the fact that they have built some 1,175 ICBMs since 1978 (compared with none by America) indicates that the Soviets are preparing for protracted nuclear war. The level of ICBM production since 1972 (some 2,000 rounds) is assessed as being far above the normal requirement for the Soviets to maintain a credible deterrent force. The net result of this, in conjunction with the previous data, is that both the numerical and technological balances have shifted significantly towards the Soviets so that they are effectively at the point of being able to carry out their twofold strategic strategy, which is first to capitalize in peacetime on the coercive leverage inherent in such a force so as to exert political influence on free-world societies, and second to employ the force in wartime in a war-winning role by ensuring the homeland's survival by destroying both the majority of Western nuclear forces (either on the ground or in flight) and the American capability to fight beyond its own shores.

The American (and hence the Western nations) vulnerability to such a strategy is readily apparent because of the lethargic and erratic policy decisions that have consistently plagued American strategic weapon development programmes over the last decade or so. The MX basing controversy, the delayed Trident missile submarine programme and the cancelled then reinstated B-1 bomber are but a few.

Theatre nuclear missiles

Hitherto there seemed to be two distinct families of missile systems, the strategic and the tactical. The tactical weapons were to an extent discounted in arms control discussions, because their ranges were so short and their warheads so comparatively small – though this distinction might have been lost on the hapless citizens of the territory (probably West Germany) over which a battle was fought. But lately great strides have been made in accuracy, range and warhead capability and with the introduction of new generation 'tactical' weapons such as Pershing II, Cruise and SS-20, theatre weapons have fused into the realms of the strategic, and this has greatly enlarged the scope of arms discussions. Some argue that this is a destabilizing factor, but it also seems to make the decision to use the first, albeit smallest, battlefield nuclear weapon that much more impossible.

AMERICAN ICBM FORCES IN 1983

Total 1398 with estimated 4482 warheads

Missile	Variant	ICBM generation	IOC date	Type	Range (km)	Warhead type	Number and yield	CEP (m)	Throw-weight (kg)	Propellant	Cold launch capability	No. deployed 1983	Notes
Titan II	–	1st	1962	heavy	15000	SRV	1×9Mt	1300	3770	liquid	no	43	being retired
Minuteman II	–	2nd	1966	light	12500	SRV	1×1.2Mt	370	730	solid	no	450	
Minuteman III	Mod I	3rd	1970	light	14000	MIRV	3×165kt	280	1090	solid	no	250	
Minuteman III	Mod 2	3rd	1979	light	14000	MIRV	3×335kt	220	1150	solid	no	300	
Peacekeeper	–	4th	late 1980s	heavy	14000	MIRV	10×335kt	60-90	3600	solid	yes	none	under development, at least 100 planned

SOVIET ICBM FORCE BUILD UP FROM 1971 TO DATE

Missile	Variant	ICBM generation	IOC date	Type	Range (km)	Warhead type	Number and yield	(CEP) (m)	Throw-weight (kg)	Propellant	Cold launch capability	No. deployed 1971	1973	1975	1977	1979	1981	1982	1983	
SS-7 SADDLER	–	2nd	1962	heavy	10400	SRV	1×3.5Mt	1850	1820	liquid		190	190	190	80	0	0	0	0	
SS-8 SASIN	–	2nd	1963	heavy	1100	SRV	1×2Mt	1850	1590	liquid		19	19	19	9	0	0	0	0	
SS-9 SCARP	Mod 1	3rd	1965	heavy	1100	SRV	1×20Mt	740	5000	liquid		}270	}308	}298	}208	}68	}0	}0	}0	
SS-9 SCARP	Mod 4	3rd	1971	heavy	1200	MRV	3×3.5Mt	1850	5680	liquid										
SS-11 SEGO	Mod 1	3rd	1966	light	8800	SRV	1×950kt	1400	1000	liquid		}970	}970	}960	}850	}650	}580	}570	}550	
SS-11 SEGO	Mod 3	3rd	1973	light	9600	MRV	3×200kt	1110	1135	liquid										
SS-13 SAVAGE	–	3rd	1969	light	8000	SRV	1×600kt	1850	680	solid		40	60	60	60	60	60	60	60	
SS-16	–	4th	1978	light	8750	SRV	1×650kt	480	980	solid		0	0	0	0	(60)	(60)	(60)	(60)	built but not deployed
SS-17	Mod 1	4th	1975	light	10000	MIRV	4×750kt	480	2740	liquid	yes	0	0	10	50	120	130*	130*	130*	*figures for Mod 1 & Mod 3
SS-17	Mod 2	4th	1977	light	11000	SRV	1×6Mt	425	2730	liquid	yes	0	0	0	0	20	20	20	20	
SS-17	Mod 3	4th	1980	light	10000	MIRV	4×750kt	350	2740	liquid	yes	0	0	0	0	0	130*	130*	130*	*figures for Mod 1 & Mod 3
SS-18	Mod 1	4th	1974	heavy	12000	SRV	1×27Mt	425	7560	liquid	yes	0	0	10	60*	36*	26*	26*	26*	*figures for Mod 1 & Mod 3
SS-18	Mod 2	4th	1976	heavy	11000	MIRV	8×900kt	425	7590	liquid	yes	0	0	0	40	154	162	162	162	
SS-18	Mod 3	4th	1977	heavy	16000	SRV	1×20Mt	350	7500	liquid	yes	0	0	0	60*	36*	26*	26*	26*	*figures for Mod 1 & Mod 3
SS-18	Mod 4	4th	1979	heavy	11000	MIRV	10×500kt	260	7590	liquid	yes	0	0	0	0	50	120	120	120	
SS-19	Mod 1	4th	1975	light	9600	MIRV	6×550kt	390	3420	liquid		0	0	60	100	180	180	180	180	
SS-19	Mod 2	4th	1978	light	10000	SRV	1×10Mt	260	3180	liquid		0	0	0	20	60	40	40	40	
SS-19	Mod 3	4th	1980	light	10000	MIRV	6×550kt	280	3410	liquid		0	0	0	0	0	80	90	110	

Notes

IOC: Initial Operational Capability.

SRV: Single Re-entry Vehicle.

MRV: Multiple Re-entry Vehicle counts as single warhead).

MIRV: Multiple Independent Re-entry Vehicle (separate warheads).

CEP: Circular Error Probability (circular area around target within which warhead has 50% chance of landing).

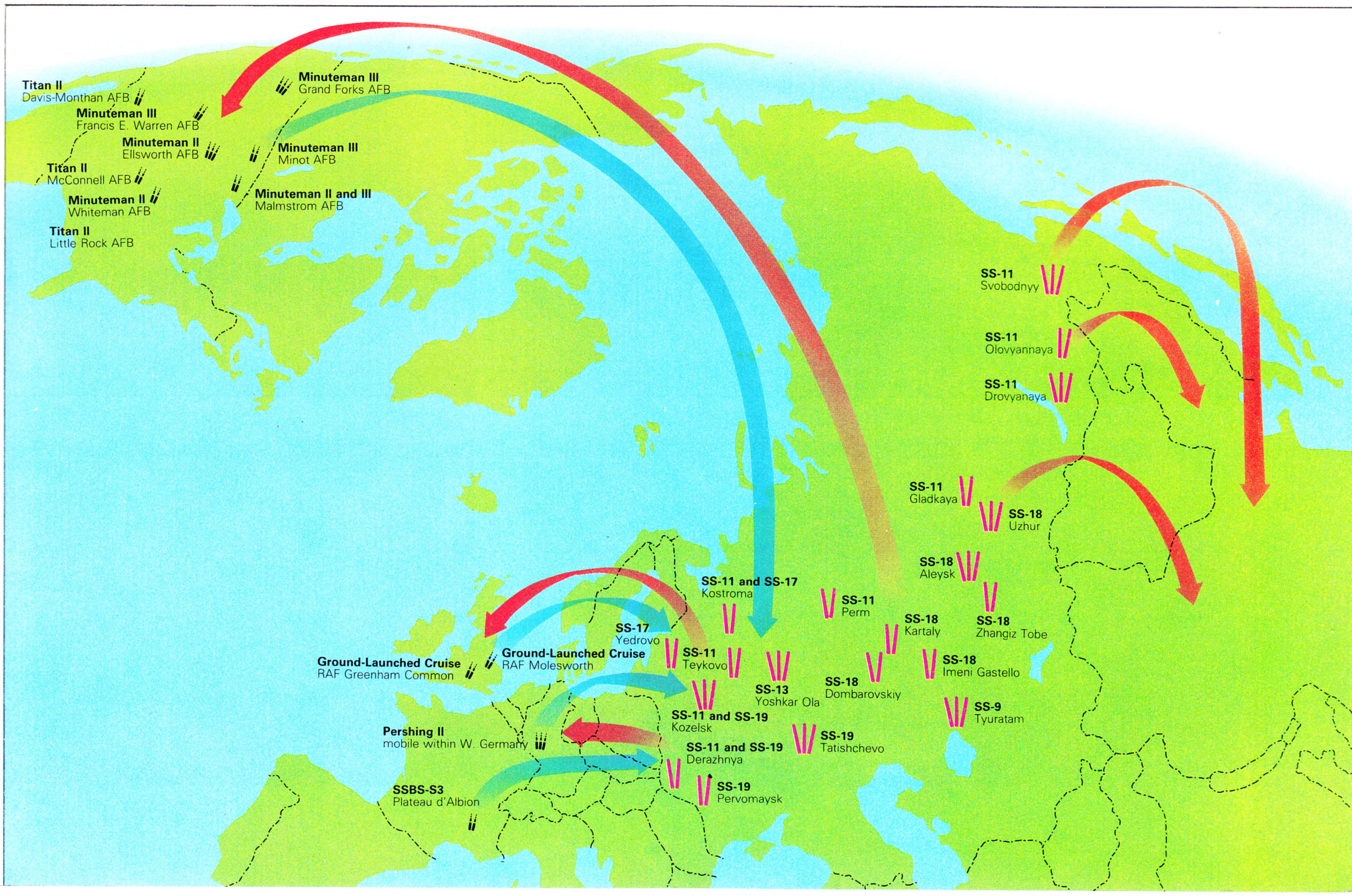
Throw-weight: deliverable payload of ICBM in kg: dependent on range, launch azimuth, re-entry angles and other such variables.

TOTAL LAND-BASED US/NATO AND FRENCH THEATRE NUCLEAR WEAPONS

Missile	Type	IOC date	Range (km)	Warhead Type	Number Yield	CEP (m)	Nuclear Payload (kg)	Propellant	Launcher	Users other than US	No. deployed by users other than US	No. deployed by US in 1983	Notes
SSBS-S3	IRBM	1980	3150	SRV	1×1.2Mt	830	not available	solid	silo	France	18		French IRBM system
Pluton	SRBM	1974	10-120	SRV	1×15kt or 1×25kt	330	c. 350 to 500	solid	tracked	France	42		French tactical SRBM system
Lance	SRBM	1972	5-121	SRV	1×10kt or 1×100kt	460	212	liquid	tracked	UK, W.Germany, Italy, Belgium, Netherlands	69	64	alternative conventional warheads available
Honest John	SRBM	1953	8-37	SRV	1×5kt or 1×25kt	830	680	solid	wheeled	Greece, Turkey	30		alternative conventional warheads available
Pershing Ia	SRBM	1969	160-740	SRV	1×60kt or 1×400kt	370	c.750	solid	wheeled	W.Germany	72	164	to be replaced in US service by Pershing II
Pershing II	MRBM	1984	1500 plus	SRV	1×20kt or 1×200kt	12-36	c.750	solid	wheeled				to replace 108 Pershing Ia in Europe
GLCM	cruise	1983	2780	SRV	1×200kt	18.5	123	turbofan	wheeled			few	total of 454 to be deployed in Europe

TOTAL LAND-BASED WARSAW PACT THEATRE NUCLEAR WEAPONS

Missile	Type	IOC date	Range (km)	Warhead Type	Number Yield	CEP (m)	Nuclear Payload (kg)	Propellant	Launcher	WarPac users other than US	No. deployed by users other than USSR	No. deployed by USSR in 1983	Notes
SS-4	MRBM	1959	220	SRV	1×1.2Mt	2300	not available	liquid	silo launch			c.200	expected to be phased out by late 1980s
SS-5	MRBM	1961	4100	SRV	1×1.2Mt	4100	not available	liquid	silo or launch pad			few	expected to be replaced by end 1983
SS-20	IRBM	1977	5000 or 7000km (50kt warhead)	SRV or MIRV	1×650kt or 1×50kt or 3×150kt	425	not available	solid	wheeled			350	total of 400 expected to be deployed
FROG-7	SRBM	1965	11-70	SRV	1×10kt or 1×100kt or 1×200kt	700	550	solid	wheeled	Bulgaria, EG, Czech, Hungary, Poland, Romania	206	c.670	alternative conventional warheads available. FROG 3 also in use
SS-21	SRBM	1976	14-120	SRV	1×10kt or 1×100kt	280	not available	solid	wheeled			c.40	eventually to replace FROG
Scud-B	SRBM	1965	80-180	SRV	1×40kt or 1×100kt	930	1000	liquid	wheeled	Bulgaria, EG, Czech, Hungary, Poland, Romania	130	c.540	some Scud-A with WarPac, Scud-C with Soviets only
SS-X-23	SRBM	1980	80-440	SRV	1×200kt	280	not available	solid	wheeled			c.30	slowly replacing Scud-B/C in Soviet service
Scaleboard	SRBM	1969	220-800	SRV	1×800kt	480	1250	solid	wheeled			c.45	being phased out
SS-22	SRBM	1977	220-880	SRV	1×550kt	320	not available	solid	wheeled			c.75	rapidly replacing Scaleboard

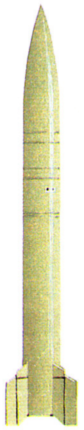

Titan II Davis-Monthan AFB
Minuteman III Francis E. Warren AFB
Minuteman II Ellsworth AFB
Titan II McConnell AFB
Minuteman II Whiteman AFB
Titan II Little Rock AFB
Minuteman III Grand Forks AFB
Minuteman III Minot AFB
Minuteman II and III Malmstrom AFB
SS-11 Svobodnyy
SS-11 Olovyannaya
SS-11 Drovyanaya
SS-11 Gladkaya
SS-18 Uzhur
SS-18 Aleysk
SS-11 and SS-17 Kostroma
SS-11 Perm
SS-18 Kartaly
SS-18 Zhangiz Tobe
SS-17 Yedrovo
SS-11 Teykovo
SS-13 Yoshkar Ola
SS-18 Dombarovskiy
SS-18 Imeni Gastello
SS-9 Tyuratam
Ground-Launched Cruise RAF Greenham Common
Ground-Launched Cruise RAF Molesworth
SS-11 and SS-19 Kozelsk
SS-19 Tatishchevo
Pershing II mobile within W. Germany
SS-11 and SS-19 Derazhnya
SS-19 Pervomaysk
SSBS-S3 Plateau d'Albion

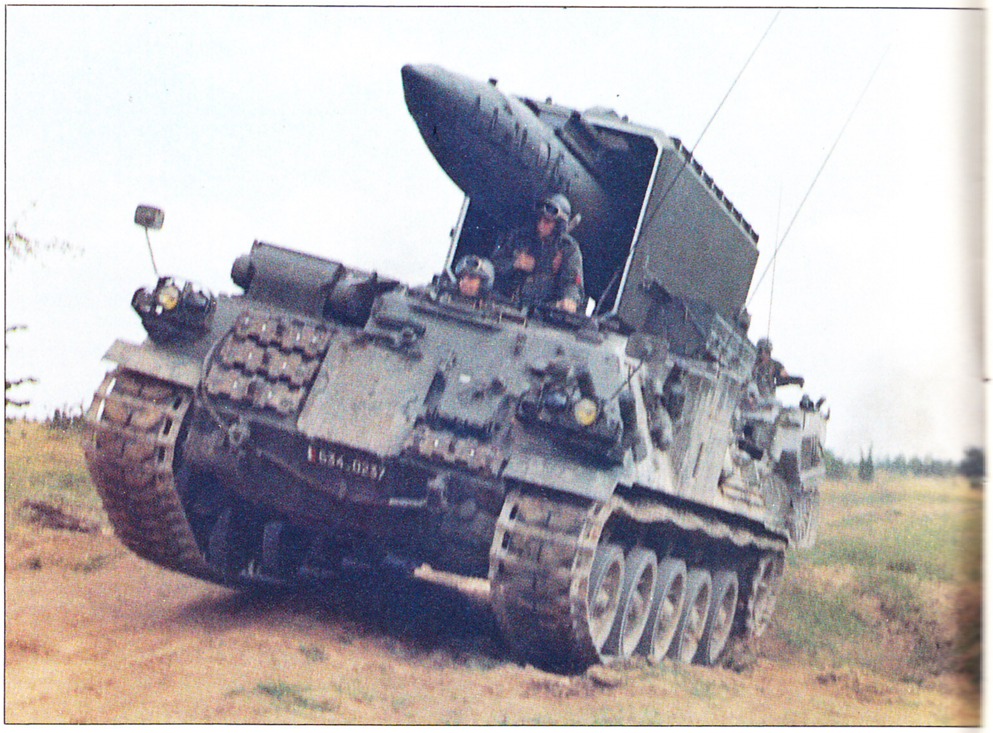
FRANCE

Pluton Short Range Battlefield Tactical Support Missile System

Developed in the late 1960s, the **Pluton** was placed in production during 1972. The first deliveries to the French army began in early 1974. Since then the French have deployed five regiments of the missiles to provide tactical nuclear support to their field armies. Each of the regiments has six launcher vehicles based on the AMX-30 main battle tank chassis, several command vehicles and the appropriate support and resupply sections. A total of 42 launcher vehicles has been produced. The missile and warhead are supplied separately to the operational units. The single-stage dual-thrust solid-propellant Pluton is fitted with a simplified inertial guidance package that is based on a SFENA semi-strapdown system. Two warheads have been developed for the missile: one is the AN-51 for use against rear-area targets and containing the same 25-kiloton MR50 nuclear weapon as the French air force's AN-52 tactical nuclear gravity bomb; the other is a 15-kiloton warhead designed as an air-burst weapon for use in the main battle zone area. As has been the case with most French nuclear weapons the design, testing and production of the systems was carried out totally by the French themselves.

In mid-1977 the French defence ministry disclosed that consideration of a **'Super Pluton'** tactical missile was already in hand for deployment in the late 1980s. This missile would have a considerably improved performance in terms of accuracy and range as well as having an improved warhead. By the early 1980s, however, an Aérospatiale study of the 'Super Pluton' and the interest generated in military circles by the American cruise missile programme had persuaded the French to turn towards the development of their own mobile land-based cruise missile. Designated **Hades** by Aérospatiale, the missile (7 m/23 ft long) will probably have an integral booster/ramjet propulsion system, a Tercom (Terrain Contour Matching) guidance system and a range in the order of 350 km (217 miles). Warhead options may include an enhanced-radiation (neutron) device as the French have shown some interest in developing this class of weapon.





Carried on a modified AMX-30 MBT chassis, Pluton is a modern and effective weapon; it went into service with the French army in 1974.

Specification

Pluton
Length: 7.64 m (25 ft 0¾ in)
Diameter: 0.55 m (1 ft 9⅔ in)
Weight: 2350 kg (5,181 lb)
Warhead weight: 350-500 kg (772-1,102 lb)
Warhead type: 15-kiloton nuclear, 25-kiloton nuclear, or training
Minimum range: 10 km (6.2 miles)
Maximum range: 120 km (75 miles)
CEP: 330 m (360 yards)
Launch vehicle: tracked AMX-30 MBT chassis
Propellant type/guidance: solid/inertial

FRANCE

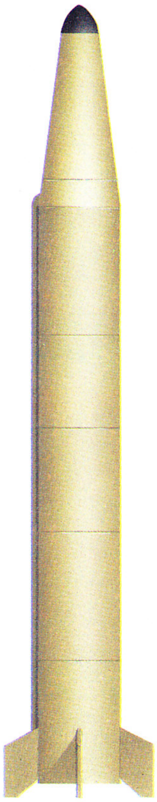
French IRBM Missile Systems

From the deployment of the first squadron in 1971, the main land-based component of France's *Force de Frappe* became 18 **SSBS S2** IRBMs. The **SSBS S2** was a two-stage inertially-guided solid-propellant missile with a CEP value of 900 m (985 yards) and was deployed in two squadrons each of nine missiles. Located on the Plateau d'Albion east of Avignon in Haute Provence in hardened underground silos, the squadrons were controlled by two heavily protected subterranean fire-control centres that had special communications links direct to the French strategic air force headquarters. The 14.8 m (48 ft 7 in) long and 1.5 m (4 ft 11 in) diameter missile had a launch weight of 31900 kg (70,325 lb) and a maximum range of 2750 km (1,708 miles), and carried a 150-kiloton yield nuclear warhead.

In 1973 a new IRBM development programme was initiated to produce a second-generation missile to replace the S2. The new missile, the **SSBS S3**, was developed by Aérospatiale under five contracts spanning the years 1974-80, and uses the same first stage as the S2. The second stage is, however, of higher performance with a warhead that includes a hardened thermonuclear charge and advanced penetration aids to counter anti-ballistic missile defences. The first test launch was in December 1976, the test firing trials being completed in the summer of 1979. Initial S3 deployment began in 1980 and by 1982 the missile had completely replaced the S2 in the two IRBM squadrons. During the deployment the ground facilities of the silo complexes were improved to allow modernization of some systems and to increase missile reliability while reducing maintenance costs. Reaction time of the S3 is said to be around 200 seconds from the order to fire.

Specification

SSBS S3
Length: 13.8 m (45 ft 3⅓ in)
Diameter: 1.5 m (4 ft 11 in)
Weight: 25800 kg (56,880 lb)
Warhead: single 1.2-megaton thermonuclear RV
Range: 3150 km (1,957 miles)
CEP: 830 m (908 yards)
Launch facility: hardened silo
Launch: hot type
Propellant type/guidance: solid/inertial



Launch of an SSBS, probably of the new S-3 type which is now replacing the S-2 in the same silos on the Plateau d'Albion in southern France. S-3 has a range of 3500 km (2,175 miles) with a single large Aérospatiale warhead with a yield of 1.2 megatons. The entire silo and missile are hardened against nuclear attack.

CHINA

Chinese MRBM/IRBM/ICBM Missile Systems

The Chinese have had a strategic missile development programme under way since the early 1960s. The first missile to become operational was a modified and lengthened version of the Soviet SS-3 'Shyster' MRBM. This single-stage liquid-fuel missile, coded **CSS-1** by the Americans and called **T1 Tong Feng** (East Wind) by the Chinese, is fired from an above-ground launch pad. The missile was initially deployed from 1966 onwards in the north eastern and north western areas of China. With a range of 1200 km (745 miles) and an estimated warhead yield of 20 kilotons, the missile has maintained a useful threat value against Soviet Far Eastern targets whilst more capable systems are deployed. A full scale test of the CSS-1 was conducted in 1966 and included the use of a fully armed warhead. The number of CSS-1s operated by the Second Artillery offensive strategic forces of the Chinese People's Liberation Army has remained at a relatively constant 50 for some time now.

The second missile to be deployed was the **CSS-2** (or **T2**) IRBM. Achieving initial operational capability in 1971, this single-stage storable liquid-propellant missile is fired from fixed above-ground launch pads. With a maximum range of around 3200 km (1,990 miles) it can engage targets in Soviet Central and Eastern Asia. The launch facilities can, if required, be relocated in a short time. The number of CSS-2s deployed is believed to be in the region of 50, and the type is equipped with either a 200-kiloton or 1-megaton warhead. Both the MRBM and IRBM forces are believed to have a reload capability.

The first Chinese ICBM, the **CSS-3** (or **T3**), was not deployed until the mid-1970s. Based in hardened underground silos, the inertially guided two-stage storable liquid-propellant CSS-3 has an estimated range of 7000 km (4,350 miles). Only 10 CSS-3s have been deployed by early 1983. The missile is thought to carry a 2-megaton yield warhead.

The next ICBM model was the **CSS-X-4** (or **T4**), which was successfully test-fired in 1980 from the Shuangchengzi missile test site in the Gobi desert. The CSS-X-4 also formed the basis of the main Chinese satellite launch vehicle, the **CSL-2** (or **FBI**). It is believed that the further development of this missile resulted the operational **CSS-5** (or **T5**) ICBM. This is estimated to have an operational range of 13800 km (8,575 miles) and to carry a 5-megaton warhead. By 1982 four CSS-5 missiles had been deployed in silos to threaten both the USSR and the USA. The total ICBM force is not expected to expand very much from its present numbers for the foreseeable future.

Specification

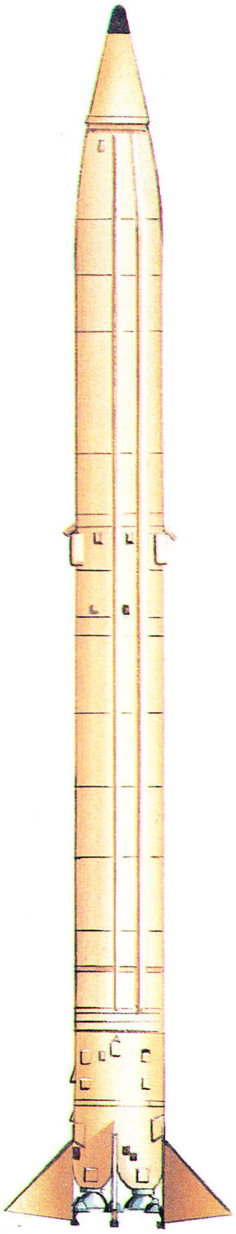
CSS-1
Type: MRBM
Length: 22.8 m (74 ft 9 in)
Diameter: 1.75 m (5 ft 9 in)
Weight: 22000 kg (48,500 lb)
Range: 1200 km (745 miles)
Warhead: 20 kilotons
Launch facility: pad
Launch: hot type
Propellant type/guidance: liquid/inertial

CSS-2
Type: IRBM
Length: 20.5 m (67 ft 3 in)
Diameter: 2.44 m (8 ft 0 in)
Weight: 28000 kg (61,730 lb)
Range: 3200 km (1,990 miles)
Warhead: 200 kilotons or 1 megaton
Launch facility: pad
Launch: hot type
Propellant type/guidance: liquid/inertial

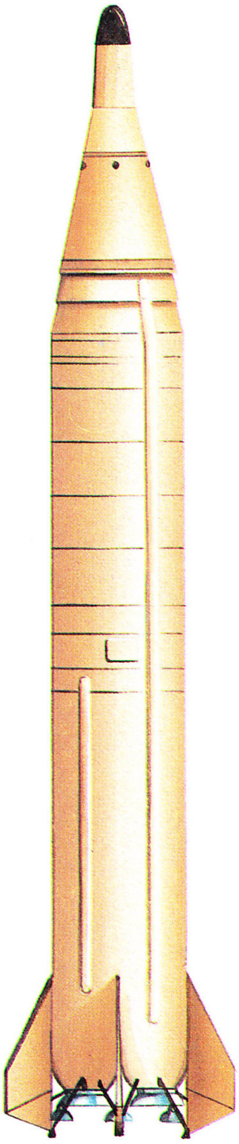
CSS-3
Type: ICBM
Length: 25.5 m (83 ft 8 in)
Diameter: 2.4 m (8 ft 0 in)
Weight: 50000 kg (110,230 lb)
Range: 6960 km (4,325 miles)
Warhead: 2 megatons
Launch facility: silo
Launch: hot type
Propellant type/guidance: liquid/inertial

CSS-X-4
Type: ICBM
Length: 32.5 m (106 ft 7½ in)
Diameter: 3.0 m (9 ft 10 in)
Weight: 150000 kg (330,690 lb)
Range: 8000 km (4,970 miles)
Warhead: 5 megatons
Launch facility: silo or pad
Launch: hot type
Propellant type/guidance: liquid/inertial

CSS-5
Type: ICBM
Length: not available
Diameter: not available
Weight: not available
Range: 13800 km (8,575 miles)
Warhead: 5 megatons
Launch facility: silo
Launch: hot type
Propellant type/guidance: liquid/inertial



CSS-1



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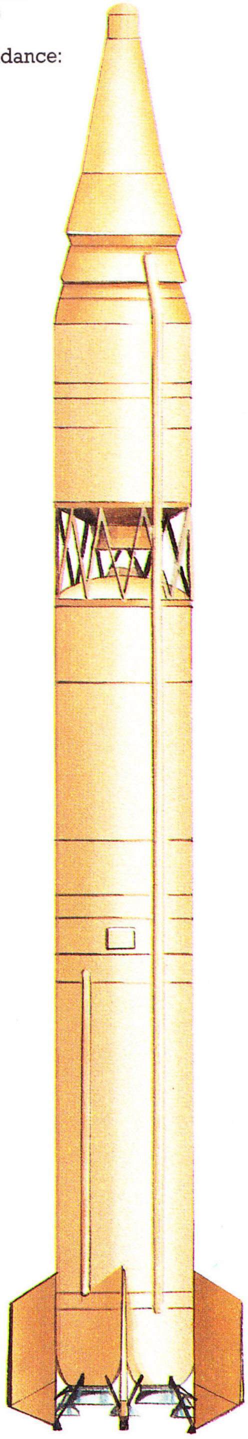
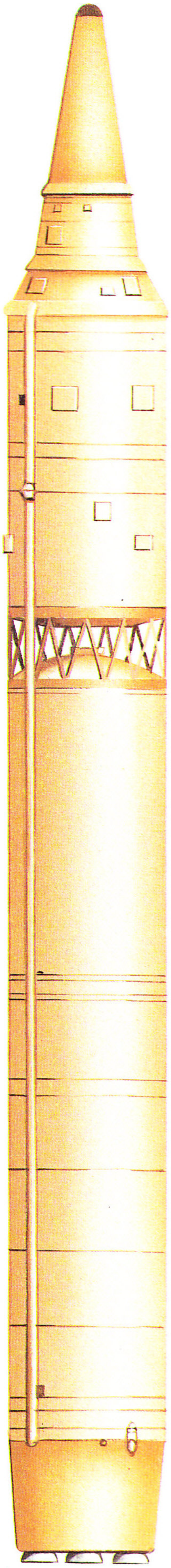


CSS-3



CSS-X-4

USA

Lance Short Range Battlefield Tactical Support Missile System

The **MGM-52** Lance battlefield support missile was first conceived of in 1962 when the Vought Corporation was chosen as the prime contractor for the programme. In 1963 the research and development contract was placed and in March 1965 the first test firing of a trials missile was conducted. After problems with the propulsion system and rocket engine had been overcome, the first production models were delivered to the US Army in 1971 for service trials. The missile was type-classified as 'standard' in 1972, with the first training battalion being activated in April of that year. The missile provides nuclear fire support at the corps level. The US Army has eight battalions in service at present. The Lance has also replaced most of the Honest John short-range missiles in service with various NATO armies. Current operators of the Lance are: USA (65 M752 launchers), UK (18 M572 launchers), West Germany (24 M572 launchers), Netherlands (nine M572 launchers), Italy (nine M572 launchers), Belgium (nine M572 launchers) and Israel (18 M572 launchers).

The Lance has a two-part Rocketdyne concentric pre-packed storable liquid-propellant motor, the outer section of which provides the thrust during the initial boost phase of the flight when the missile is under the control of the onboard simplified inertial guidance system; once this system detects that the cruise velocity has been attained, the inner propellant section is ignited to take over the propulsion until the guidance unit commands it to shut down so as to leave the missile in free flight for the terminal phase of its trajectory. The missile is spin-stabilized in flight by the expulsion of propellant gases through canted vents in the missile body. The Lance system is normally carried on two tracked derivatives of the M113 APC family: the M752 self-propelled erector-launcher vehicle carries one ready-to-fire missile, and the M688 loader-transporter vehicle carries two reload missiles (minus their fins) and a loading hoist. A single-rail lightweight launcher has also been developed for delivery by helicopter or parachute into the battle area.

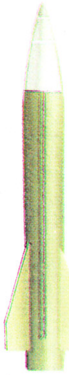
The warhead options for the Lance include the NATO standard 212-kg (467-lb) M234 10- to 100-kiloton optional yield weapon. The US Army is replacing some of these with a version based on the W70-4 weapon that has built-in features allowing it to operate as a ½-kiloton low-yield enhanced-radiation (neutron) device that minimizes blast damage and residual radiation but maximizes the output of fast radiation at the time of detonation to increase personnel casualties. This effect is of considerable use when large concentrations of tanks and APCs are engaged by nuclear weapons. All the NATO nuclear warheads for Lance are held by the Americans under a dual-key arrangement. Israel does not have any nuclear warheads for Lance but uses the M251 cluster munition warhead instead. The M251 is also used by the US Army and the Netherlands. This air-burst warhead is filled with 836 0.43-kg (0.95-lb) sphere-shaped anti-personnel/anti-matèriel fragmentation bomblets that can saturate a 820-m (900-yard) diameter circle with lethal fragments. This is of particular use to Israel as a possible air-defence suppression system that does not risk any personnel casualties in its use.

Vought is currently developing an **Improved Lance** to meet the US Army's Corps Support System programme requirement. The new missile will be compatible with the current lance systems and will be effective into the 1990s. Improved Lance will have three times the range, six times the accuracy and a 30 per cent increase in payload when compared to the present missile.

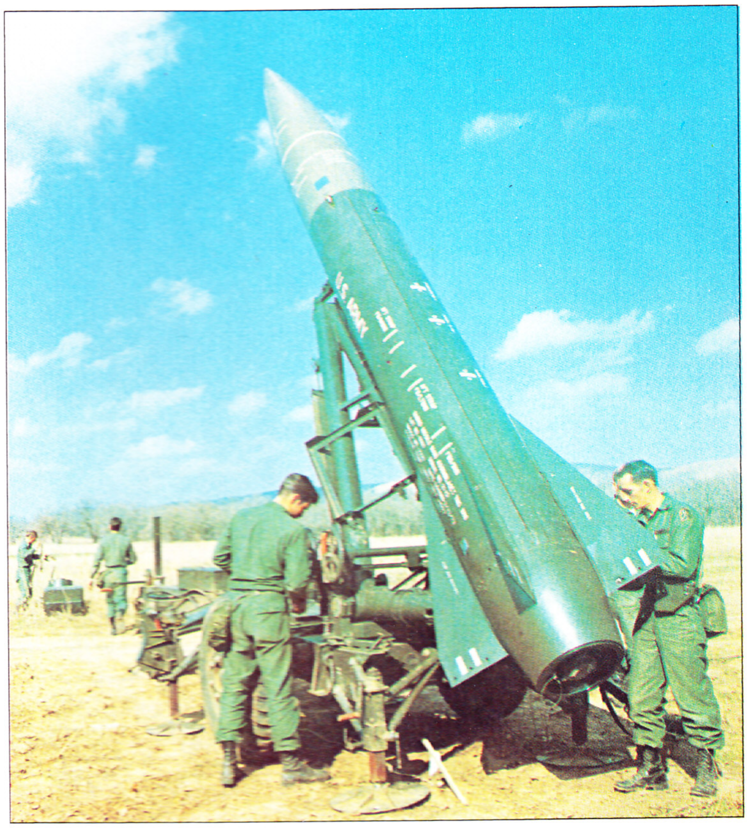
Specification

MGM-52C Lance

Length: 6.17 m (20 ft 3 in)
Diameter: 0.56 m (1 ft 10 in)
Weight: 1530 kg (3,373 lb) with nuclear warhead, and 1778 kg (3,920 lb) with conventional warhead
Warhead weight: 212 kg (467 lb) nuclear, and 454 kg (1,000 lb) conventional
Warhead types: 10/100-kiloton M234 nuclear, M251 conventional cluster and training
Minimum range: 4.8 km (3 miles)
Maximum range: 121 km (75 miles) with nuclear warhead, and 70 km (43 miles) with conventional warhead
CEP: 455 m (500 yards)
Launch vehicle: tracked M572
Propellant type/guidance: liquid/simplified inertial

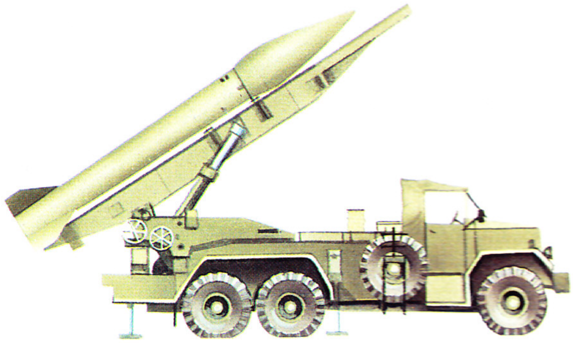


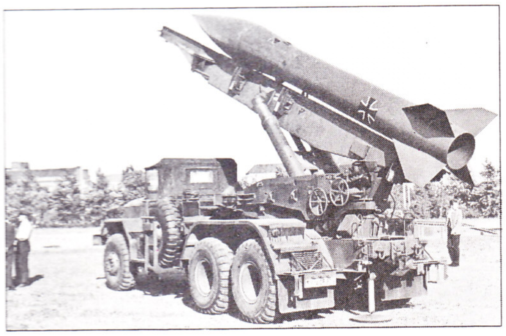
Lance is a mobile battlefield missile with a range of up to 120 km (75 miles), with a nuclear warhead. This Lance of the US Army is mounted on the lightweight launcher which can be carried by helicopter or dropped by parachute. Lance is also fired from a tracked amphibious vehicle.



USA

Honest John Short Range Tactical Battlefield Support Missile System





Now obsolete, Honest John is still found in some NATO armies, this example being used by West Germany. A clumsy artillery rocket, it is carried singly on a truck which has to be aimed at the target, range being determined by the elevation of the launch rail.

The **MGR-1 Honest John** missile first entered service in its **MGR-1A** form in 1953. In 1960 the improved **MGR-1B** was introduced, and this has now been phased out of service with most NATO countries except Greece and Turkey in favour of the Lance system. Greece currently employs three battalions with 12 launchers, whilst Turkey has four battalions with a total of 18 launchers. The only other country that still has Honest John in active service is South Korea, which has two battalions with a total of 12 launchers. Honest John also served with the armies of Belgium, Denmark, France, Italy, Japan, the Netherlands, the UK, the USA and West Germany. France replaced her Honest Johns with Pluton, whilst Denmark and Japan did not bother to introduce any replacement system.

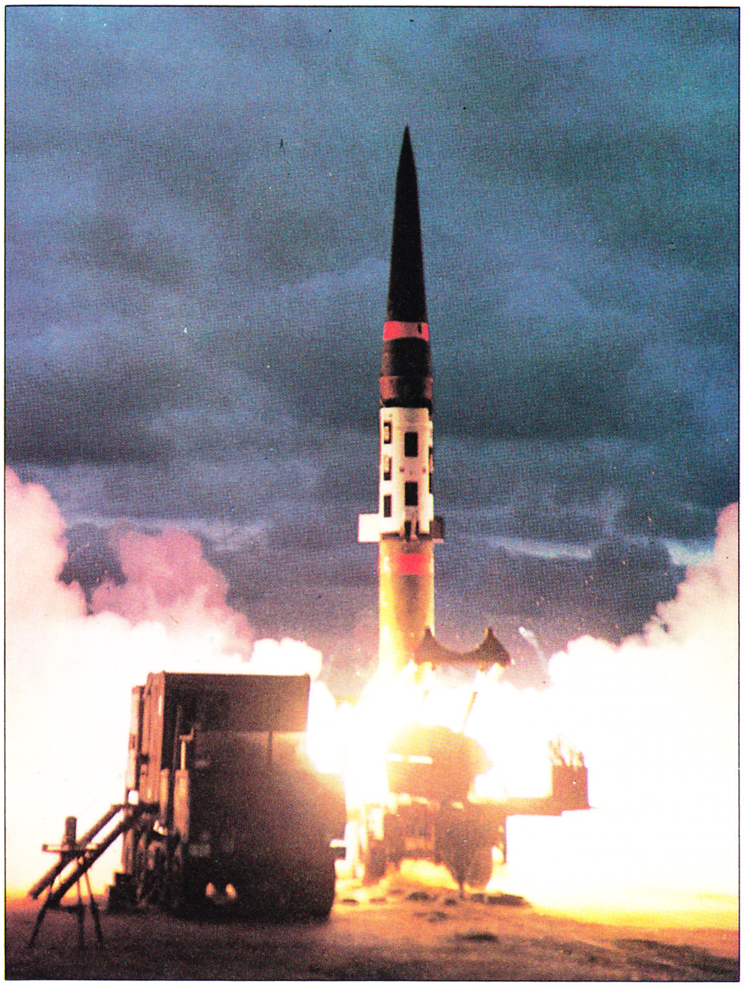
The Honest John is individually launched from a rail on its own truck launcher-transporter. The Mach-1.5 missile is powered by a solid-propellant motor and is unguided, being ballistically aimed at its target. The warhead can either be a 680-kg (1,500-lb) HE or a 680-kg (1,500-lb) 5/25-kiloton nuclear type. An alternative cluster munition warhead has also been developed and is known to have been sold to South Korea as recently as 1977. Both Greece and Turkey have access to NATO nuclear warheads for Honest John, although these are in American custody under a dual-key arrangement. It is probable that both countries will phase out the missile during the mid-1980s as a result of the system's increasing obsolescence.

Specification

MGR-1B Honest John

Length: 7.57 m (24 ft 10 in)
Diameter: 0.76 m (2 ft 6 in)
Weight: 2136 kg (4,710 lb)
Warhead weight: 680-kg (1,500-lb) nuclear or conventional; 564-kg (1243-lb) chemical
Warhead types: 5/25-kiloton nuclear, high explosive, cluster munition and training
Minimum range: 7.2 km (4½ miles)
Maximum range: 37 km (23 miles)
CEP: 830 m (910 yards)
Launch vehicle: wheeled truck launcher-transporter
Propellant type/guidance: solid/none

Pershing Short Range Battlefield Support Missile System



Large and cumbersome, the US Army Pershing nevertheless brought a new level of range of up to 740 km (460 miles) when it entered service in 1962. Pershing Ia, seen at launch, is soon to be replaced by Pershing II which has super-accurate radar guidance and thus does not need such a high-yield warhead.

The two-stage solid-propellant **MGM-31 Pershing I** missile was first deployed in 1962, and the entire system was carried on four XM474 tracked vehicles. The first deployment to Europe occurred in 1964 when the missile served in the Quick Reaction Alert role for the Central European theatre of operations and as a general nuclear delivery system for field armies. The Pershing was grouped into battalions comprising a headquarters battery, a service battery and four firing batteries. The West German air force also adopted the Pershing I, receiving a total of 72 launchers. Because of the poor mobility characteristics of the tracked vehicles, in 1966 a development contract was placed with Martin-Marietta to improve the system and the missile's capabilities.

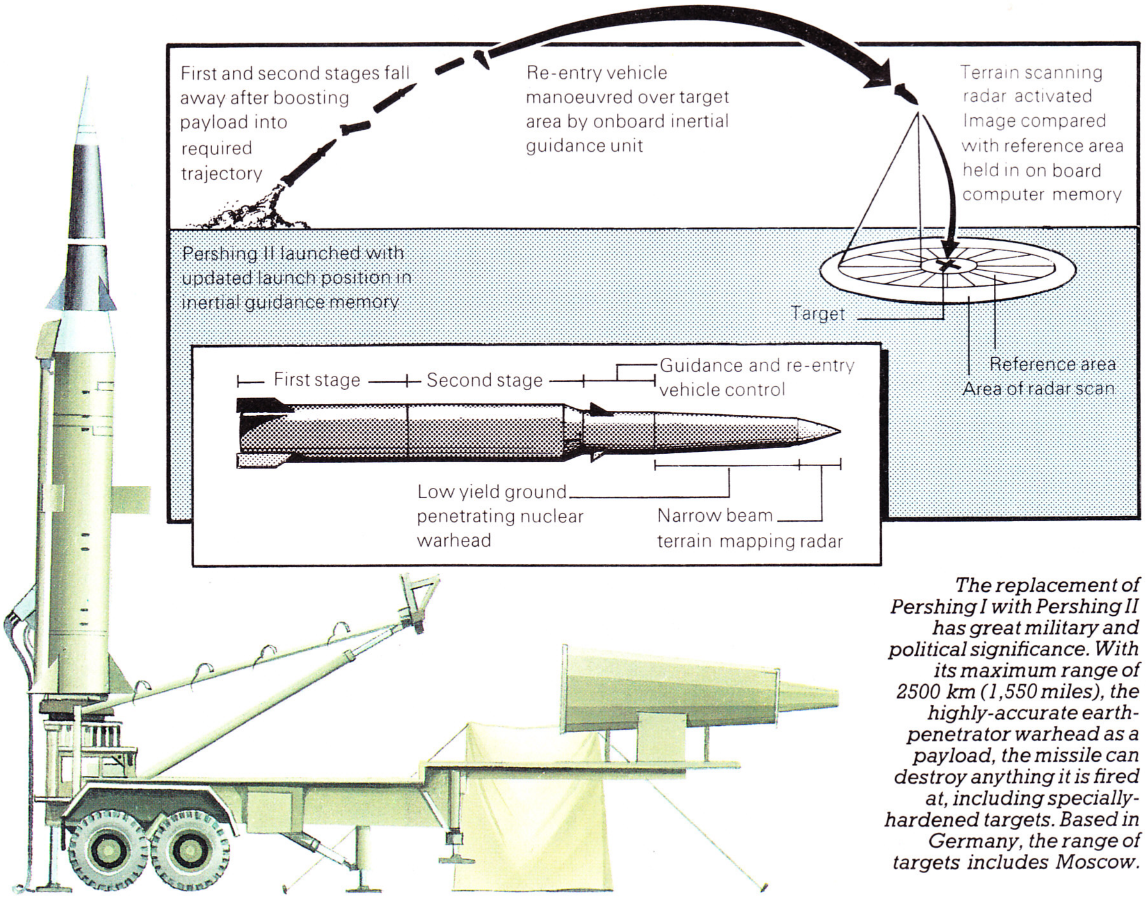
In November 1967 production started of the improved **Pershing Ia** to replace the Pershing I in both the US Army and West German air force. The first operational Pershing Ia was deployed in 1969. The most obvious improvement was the replacement of the XM474 tracked vehicles by wheeled vehicles derived from the M656 5-ton truck chassis. This greatly enhanced the system's mobility over paved roads and across country. It also allowed the warhead to be carried with the missile rather than on its own vehicle as had been the case with the Pershing I. The system's firing unit now consisted of an articulated truck and trailer combination that served as the erector-launcher, a transporter for the programme tester and generator units, a firing battery control centre vehicle and a radio terminal set vehicle with an inflatable aerial. A series of subsequent system improvements has allowed the reaction time to be reduced still further, and the introduction of an automatic reference system and sequential launch adapter in 1976-7 allows the Pershing unit commander to fire up to three missiles from a single control station at previously unsurveyed launch sites. The current US Army inventory of Pershing systems is 164 launchers, of which 108 are in Western Europe. The West Germans replaced their Pershing I systems on a one-for-one basis by the Pershing Ia.

In 1978 the advanced development programme of the **Pershing II** system was successfully completed. This missile, which has a range of more than 1490 km (925 miles), is a modular modernization of the Pershing Ia with a considerably enhanced accuracy and range. The Pershing II is expected to achieve an initial operational capability date of 1984 to replace the Pershing Ia in Europe and then presumably in the continental United States. The European deployment is to improve NATO's intermediate-range theatre nuclear weapons stockpile and is a direct response to the Russian deployment of the SS-20 IRBM system.

The Pershing II's terminal guidance system utilizes an all-weather radar correlation unit in its ceramic nose cone that compares the radar returns with a pre-recorded onboard radar profile of the target. This RADAG system allows CEP values of between 12 and 36 m (40 and 120 ft) to be achieved. In turn this allows the higher yield 60- and 400-kiloton air-burst versions of the W50 warhead of the Pershing Ia to be replaced by the W85 200-kiloton air-burst warhead and the W86 20-kiloton earth-penetrator warhead of the Pershing II. Thus targets which might have to be attacked by two or three of the older missiles need only one Pershing II, the earth penetrator warhead being of particular importance as before detonation it can penetrate the overlying 30 m (1000 ft) or so of soil and concrete that conceal Soviet rear zone command, control and communications facilities. The older Pershing Ia will stay in the West German air force's inventory for some time to come, the nuclear warheads for these being held under a dual-key agreement.

Specification

MGM-31A Pershing Ia
Length: 10.6 m (34 ft 9½ in)
Diameter: 1.0 m (3 ft 3⅓ in)
Weight: 4600 kg (10,141 lb)
Warhead weight: about 748 kg (1,650 lb)
Warhead types: 60-kiloton nuclear, 400-kiloton nuclear and training
Minimum range: 161 km (100 miles)
Maximum range: 740 km (460 miles)
CEP: 365 m (400 yards)
Launch vehicle: wheeled M656 truck and trailer combination
Propellant type/guidance: solid/inertial


First and second stages fall away after boosting payload into required trajectory
Re-entry vehicle manoeuvred over target area by onboard inertial guidance unit
Terrain scanning radar activated
Image compared with reference area held in on board computer memory
Pershing II launched with updated launch position in inertial guidance memory
Target
Reference area
Area of radar scan
First stage
Second stage
Guidance and re-entry vehicle control
Low yield ground penetrating nuclear warhead
Narrow beam terrain mapping radar

The replacement of Pershing I with Pershing II has great military and political significance. With its maximum range of 2500 km (1,550 miles), the highly-accurate earth-penetrator warhead as a payload, the missile can destroy anything it is fired at, including specially-hardened targets. Based in Germany, the range of targets includes Moscow.

USA

Titan II Heavy ICBM Missile System

Built by Martin-Marietta, the **LGM-25C Titan II** is an improved version of the earlier **HGM-25A Titan I** ICBM. Deployed originally in 1962 the missile is the last survivor of the American first-generation liquid-propellant missiles. A total of 54 of the missiles was deployed in six nine-missile squadrons. However, in 1978 and 1980 two missiles were destroyed in 'Broken Arrow'-classification nuclear accidents that occurred in their silos. These have not been replaced. In 1981 it was tentatively announced that the remaining 52 missiles were to be progressively withdrawn between 1983 and 1987 due to their age and declining military effectiveness and in order to make way for the new MX missile. However, the MX basing problems have resulted in this idea being given a lower priority for the present. By mid-1983 only 43 Titan IIs will be in service. In early 1980 it was learnt that the Titan II force was having its AC/IBM inertial guidance systems updated to remain effective throughout the missiles' remaining lifetime. The work was completed in 1981. As the heaviest American ICBM deployed, the Titan is fitted with a General Electric Mk 6 re-entry vehicle carrying a 9-megaton W53 thermonuclear warhead, elaborate penetration aids and an onboard computer with a three-target selection capability. The two-stage missile has a maximum burn out speed of more than 24000 km/h (14,900 mph) and a maximum range in excess of 15000 km (9,325 miles). The maximum ceiling attained during its flight is around 1500 km (930 miles). The propulsion system comprises two Aerojet LR87-Aj-5 gimballed rocket motors each rated at 97975-kg (216,000-lb) thrust on the first stage and an Aerojet LR91-AH5 rocket motor rated at 45360-kg (100,000-lb) thrust for the second stage.

Specification

LGM-25C Titan II

Length: 31.4 m (103 ft 0 in)

Diameter: 3.5 m (10 ft 0 in)

Weight: 149690 kg (330,000 lb)

Warhead: single 9-megaton thermonuclear RV

Range: 15000 km (9,325 miles)

CEP: 1300 m (1,420 yards)

Launch facility: hardened silo

Launch: hot type

Propellant type/guidance: liquid/inertial

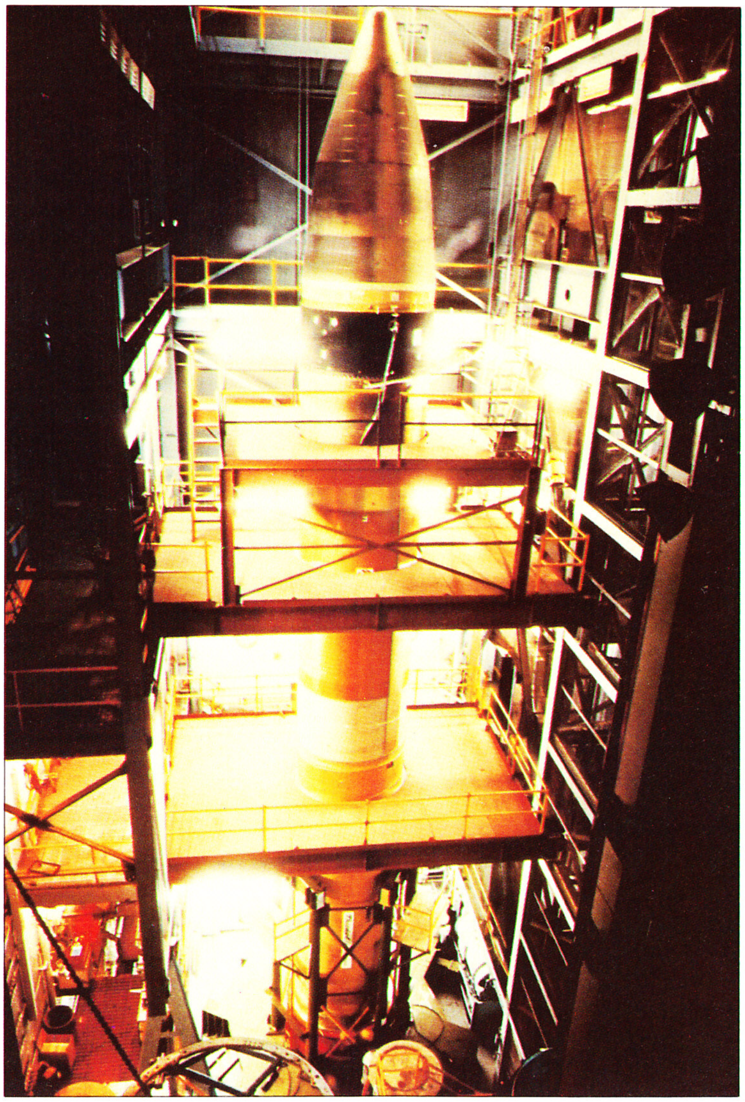
Titan was developed by Martin as the first tandem two-stage ICBM, the photograph showing a test launch from Cape Canaveral of a Titan I. From this was developed the larger Titan II, shown in the profile.

USA

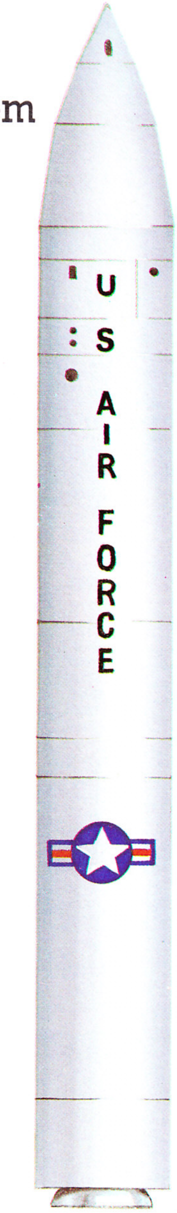
MGM-118 (MX) Peacekeeper Heavy ICBM Missile System

Serious development of the **Martin-Marietta MX** missile began in 1974 under President Ford's administration, and has progressed well despite all the problems associated with its basing. The first of 20 test rounds are due for firing in 1983 and the first production rounds will be operationally deployed in the late 1980s. The four-stage solid-propellant missile has been designed to have considerably improved accuracy, range and payload features when compared with current ICBMs. The missile is encased at the time of its assembly in a protective launch canister compatible with a variety of basing options. When the missile is fired a solid-propellant unit in the base of the canister is ignited to eject the missile in a cold launch clear of the protective casing. The first-stage propulsion motor system is then fired automatically once the missile is some 24-30 m (80-100 ft) clear. A protective shroud over the nose assembly and a 6 mm (¼ in) thick rubber-like skin over the missile's surface protects it from dust and debris.

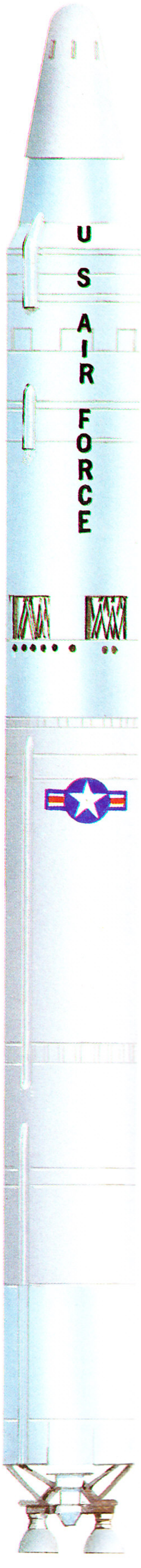
The first stage is powered by Thiokol rockets and burns out at an altitude about 24385 m (80,000 ft). The second-stage Aerojet propulsion unit then takes over. This stage burns out at about 85345 m (280,000 ft), whereupon the final solid-propellant Hercules Aerospace motor ignites. The nose shroud is then jettisoned at around 97-km (60-mile) altitude to uncover the MIRV payload. Final third-stage burn out occurs around 116-km (72-mile) altitude when the fuel load has been totally exhausted. During all three powered flight stages the guidance sys-



The first completely assembled Peacekeeper ICBM photographed on static test in 1982. Formerly known only as MX (missile X), the Peacekeeper ICBM has been planned for over 12 years. It weighs 95 short tons at lift-off, compared with 38 for Minuteman III.



MX Peacekeeper



Titan II

MGM-118 Peacekeeper Heavy ICBM Missile System (continued)

tem has constantly modified the flight path so that all the solid fuel aboard is consumed, this meaning that no propulsion cut-off system is required on the third stage.

The fourth-stage Rockwell International RS-34 assembly is then released. This carries a post-boost liquid-propellant propulsion motor with multiple-burn capability, the Northrop advanced inertial reference sphere guidance system, attitude-reference systems, and the Avco re-entry package of 10 MIRVs with penetration aids. The rocket motor is used to target the MIRVs. Once the course of the dispensing bus is set a warhead is released and the RS-34 backs away. The newly released MIRV is then spin-stabilized by the two small rockets it carries. As soon as the warhead is well clear of the RS-34 the motor re-ignites and the assembly changes course to engage the next target. The process is repeated until all 10 MIRVs have been launched. The individual MIRV re-entry vehicle most favoured as the MX payload is the General Electric Mk 12 A (1.813 m/6 ft 11⅓ in long and 0.542 m/1 ft 9⅓ in base diameter) carrying a W78 335-kiloton yield warhead. Another possibility is the new RV being developed as part of the Advanced Ballistic Re-entry Vehicle (ABRV) programme. The MX is now designated MGM-118A Peacekeeper

Specification

MGM-118A Peacekeeper
Length: 21.6 m (70 ft 10½ in)
Diameter: 2.337 m (7 ft 8 in)
Weight: 88450 kg (195,000 lb)
Warhead: 10 335-kiloton MIRVs
Range: 14000 km (8,700 miles)
CEP: 60 to 90 m (65 to 100 yards)
Launch facility: hardened silo
Launch: cold type
Propellant type/guidance: solid/inertial

USA

Minuteman Lightweight ICBM Missile System

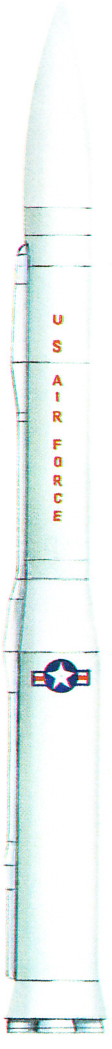
The **Minuteman** family of ICBMs comprised four variants, of which only the **Minuteman II** and **Minuteman III** remain in service. The original **LGM-30A Minuteman I** equipped one Strategic Air Command missile wing in 1963. An improved **LGM-30B Minuteman I** with increased range and of longer length was then brought into service with the next four wings formed, whilst the sixth was equipped in 1966 with the **LGM-30F Minuteman II.** Both the Minuteman II and the **LGM-30G Minuteman III,** introduced in 1970, then replaced the two Minuteman I variants. The six deployed strategic missile wings are currently the 341st at Malmstrom, Montana, with 150 MMII and 50 MMIII; the 44th at Ellsworth, South Dakota, with 150 MMII; the 91st at Minot, North Dakota, with 150 MMIII; the 351st at Whiteman, Missouri, with 150 MMII; the 90th at F.E. Warren, Wyoming, with 200 MMIII; and the 321st at Grand Forks, North Dakota, with 150 MMIII.

The wings are dispersed over wide geographical areas and are organized in squadrons of five flights each with 10 hardened missile silos and an underground launch control centre. If the control centre is incapacitated for any reason, launch control is passed either to one of two control centres within the squadron that can also serve as a squadron control centre or, in the case of some 200 or so missiles, to a specially configured Strategic Air Command airborne command post aircraft that carries an airborne launch control and retargeting system.

The three-stage solid propellant LGM-30F Minuteman II is essentially an upgraded Minuteman I with increased range and a more sophisticated guidance system. The latter has an eight-target selection capability giving increased accuracy and a single Mk 11G thermonuclear RV with Tracor Mk 1A chaff-dispenser penetration aids. Several of the Minuteman IIs are specially configured to carry communications equipment instead of a warhead to act as Emergency Rocket Communications Systems for the backup role of crisis communication to surviving nuclear strike forces in a post-nuclear exchange environment.

The improvements of the LGM-30G Minuteman III over its predecessor are confined mainly to the third stage and the warhead re-entry system. The main feature is the introduction of three MIRVs as the payload. The post-boost bus has been fitted with a small Bell Aerosystem liquid-propellant rocket motor, four smaller roll rockets and six slightly larger pitch stabilizer jets. All of these are under the command of the onboard Rockwell International inertial guidance system. Currently 250 of the Minuteman III force have the Mk 12 re-entry vehicle containing three W62 165-kiloton yield warheads with chaff and decoy penetration aids.

On the remaining 300 missiles, and presumably on the further 50 missiles that will replace 50 Minuteman IIs by the mid-1980s, the Mk 12A re-entry vehicle is fitted. This is about 16 kg (35 lb) heavier than the Mk 12 but as a result of the miniaturization of certain components remains identical in size. It is able to carry three W78 335-kiloton yield warheads with slightly better CEP capability. The associated penetration aids also remain. Considerable effort is being devoted to sustain the Minuteman force's operational capabilities and survivability prospects during any nuclear-exchange scenario.



Minuteman III was the ultimate development of the neat Minuteman developed in 1958-60 as the first solid-propellant ICBM. Among its new features were multiple independently targeted warheads (up to three 335-kiloton units) and a Command Buffer System for rapid retargeting. A total of 550 of this version was put into silos.

Specification

LGM-30F Minuteman II and LGM-30G Minuteman III
Length: 18.20 m (59 ft 8½ in)
Diameter: LGM-30F 1.83 m (6 ft 0 in); LGM-30G 1.85 m (6 ft 0⅘ in)
Weight: LGM-30F 31750 kg (70,000 lb); LGM-30G 34500 kg (76,058 lb)
Warhead type: LGM-30F single 1.2-megaton thermonuclear RV; LGM-30G three 165- or 335-kiloton nuclear MIRVs
Range: LGM-30F 12510 km (7,775 miles); LGM-30G 14000 km (8,700 miles)
CEP: LGM-30F 370 m (405 yards); LGM-30G 280 m (305 yards) with Mk 12 or 220 m (240 yards) with Mk 12 RVs
Launch facility: hardened silo
Launch: hot type
Propellant type/guidance: solid/inertial

USA

American Ground-Launched Cruise Missile System

For many years the only cruise missiles in service have been Russian, but because of the combined efforts of Western protesters and the Western media the term 'cruise' today means a quite small and slow missile which the US Air Force intends to deploy in small numbers from the mid-1980s. Actually called the **BGM-109G**, and a member of the versatile **General Dynamics Tomahawk** family, it has been developed to give the NATO alliance its previously missing theatre nuclear strike capability against important fixed targets such as major airfields, naval bases and hardened missile silos. It makes sense to use a super-accurate missile against such targets, because it frees manned aircraft for use in the conventional role against moving targets which at present only they can attack.

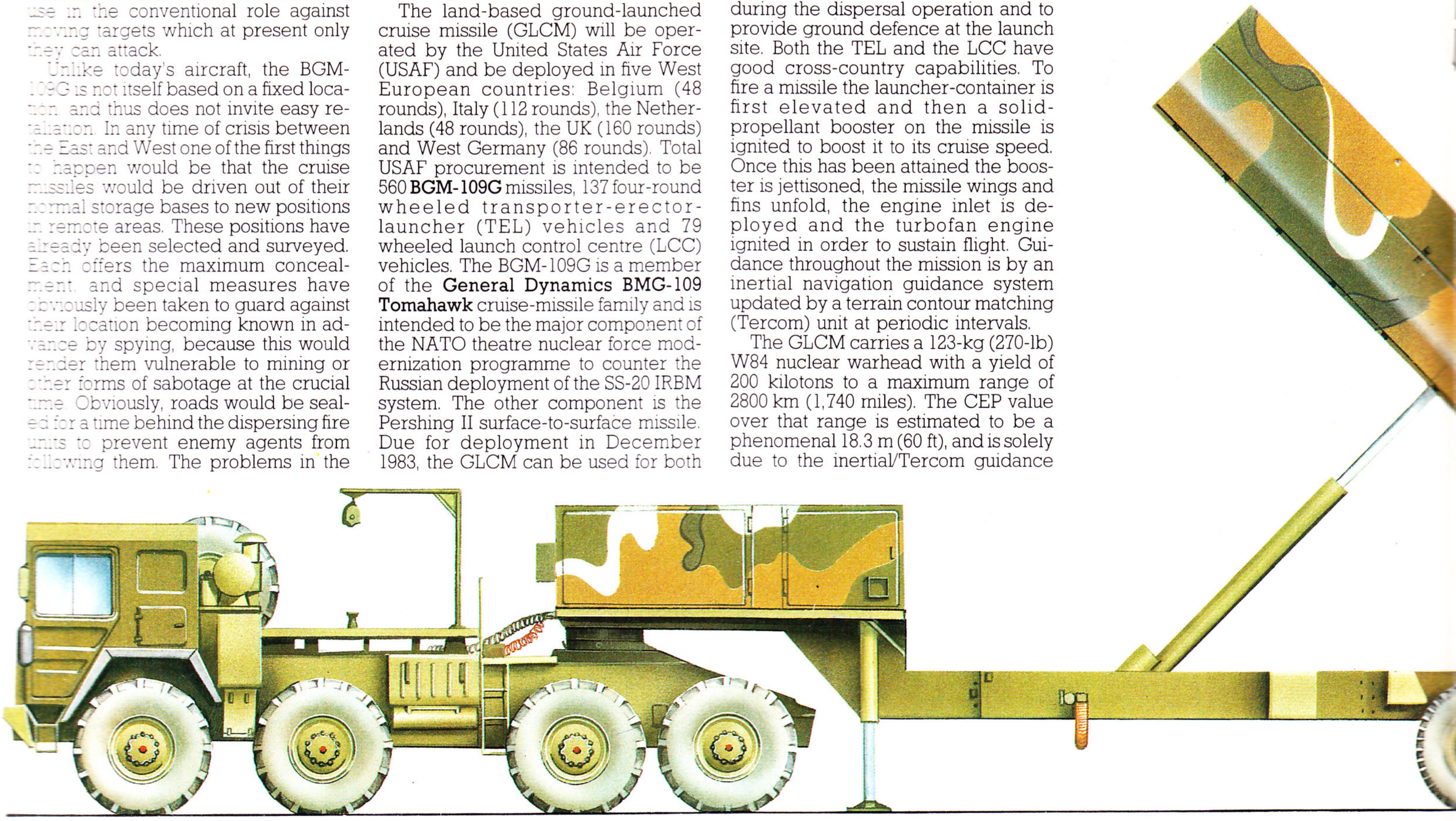
Unlike today's aircraft, the BGM-109G is not itself based on a fixed location and thus does not invite easy retaliation. In any time of crisis between the East and West one of the first things to happen would be that the cruise missiles would be driven out of their normal storage bases to new positions in remote areas. These positions have already been selected and surveyed. Each offers the maximum concealment, and special measures have obviously been taken to guard against their location becoming known in advance by spying, because this would render them vulnerable to mining or other forms of sabotage at the crucial time. Obviously, roads would be sealed for a time behind the dispersing fire units to prevent enemy agents from following them. The problems in the West are greater than in the Warsaw Pact powers, where the population as a whole are not mobile and the area available for concealing mobile long-range missiles far greater.

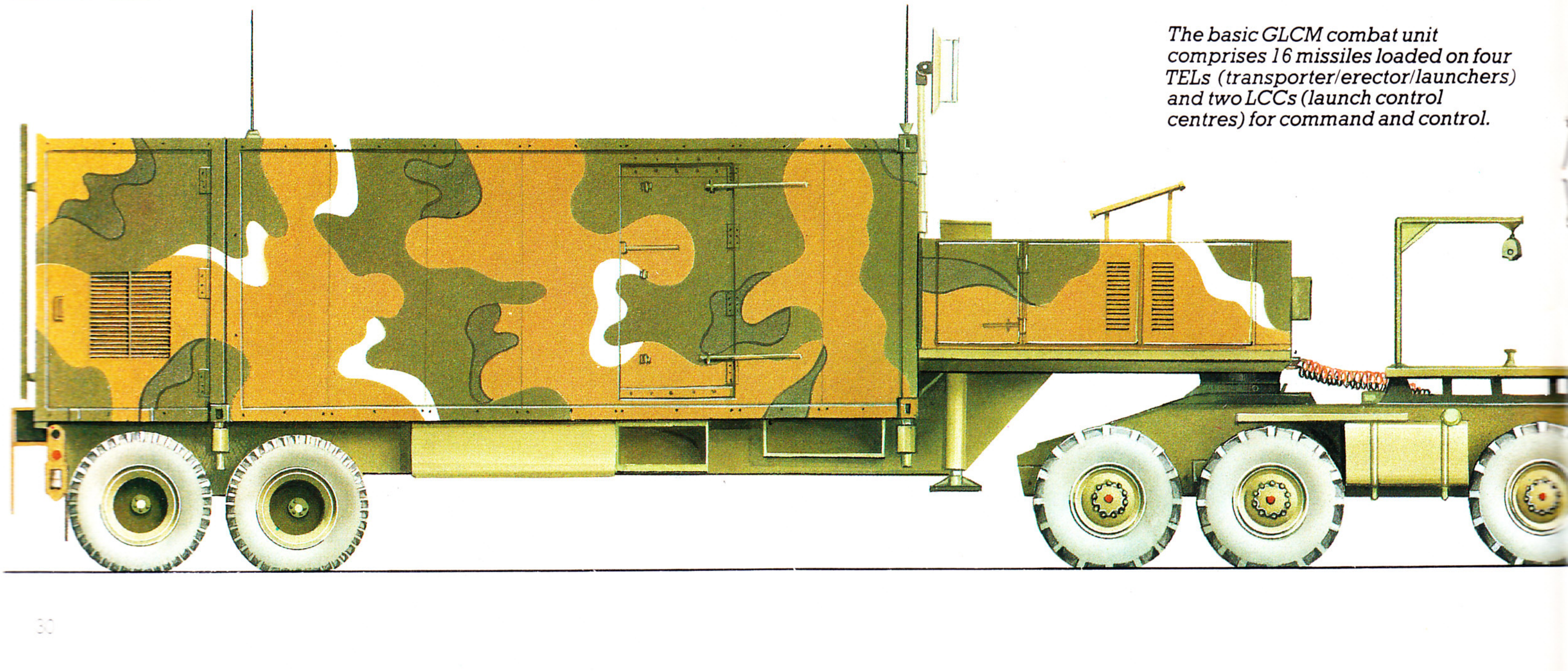
The other big question mark hanging over such slow-flying missiles is their ability to penetrate hostile airspace. In 1944 southern England rapidly got the upper hand over very similar missiles which were fired in much larger numbers (several thousands) using piston-engine fighters and ordinary anti-aircraft guns. Modern radars, computers, jet interceptors and precision missile combine to form a defence network that a 805 km/h (500-mph) missile would certainly find very difficult to pierce.

The land-based ground-launched cruise missile (GLCM) will be operated by the United States Air Force (USAF) and be deployed in five West European countries: Belgium (48 rounds), Italy (112 rounds), the Netherlands (48 rounds), the UK (160 rounds) and West Germany (86 rounds). Total USAF procurement is intended to be 560 **BGM-109G** missiles, 137 four-round wheeled transporter-erector-launcher (TEL) vehicles and 79 wheeled launch control centre (LCC) vehicles. The BGM-109G is a member of the **General Dynamics BMG-109 Tomahawk** cruise-missile family and is intended to be the major component of the NATO theatre nuclear force modernization programme to counter the Russian deployment of the SS-20 IRBM system. The other component is the Pershing II surface-to-surface missile. Due for deployment in December 1983, the GLCM can be used for both selective or general nuclear release options against either fixed targets (such as lines of communication, logistical stores dumps, airfields and command and control facilities) or stationary tactical targets such as troop staging and assembly areas.

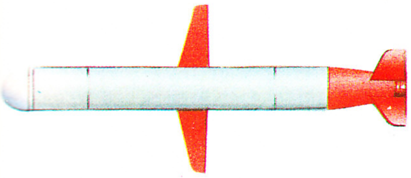
The GLCM is deployed in firing units of 16 missiles carried on four TELs with two mobile LCCs in attendance. The unit is in peace located in a hardened concrete shelter at its home base, but will deploy to pre-surveyed firing positions offering good natural concealment at distances of about 160 km (100 miles) from the base if hostilities seem imminent. Escorts from the host nation's armed forces will accompany the unit to provide security during the dispersal operation and to provide ground defence at the launch site. Both the TEL and the LCC have good cross-country capabilities. To fire a missile the launcher-container is first elevated and then a solid-propellant booster on the missile is ignited to boost it to its cruise speed. Once this has been attained the booster is jettisoned, the missile wings and fins unfold, the engine inlet is deployed and the turbofan engine ignited in order to sustain flight. Guidance throughout the mission is by an inertial navigation guidance system updated by a terrain contour matching (Tercom) unit at periodic intervals.

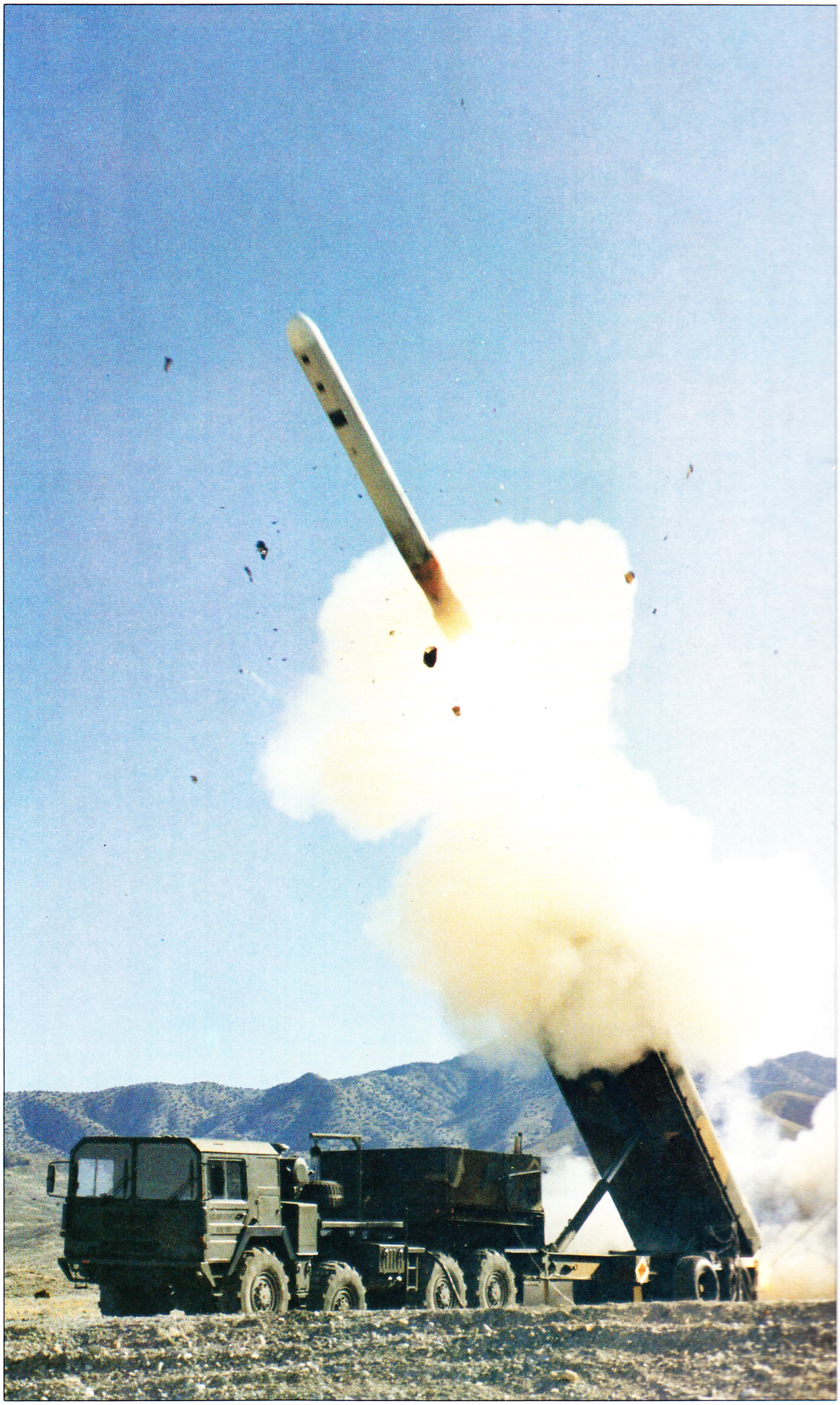
The GLCM carries a 123-kg (270-lb) W84 nuclear warhead with a yield of 200 kilotons to a maximum range of 2800 km (1,740 miles). The CEP value over that range is estimated to be a phenomenal 18.3 m (60 ft), and is solely due to the inertial/Tercom guidance system. The major advantage of the GLCM is its ability to fly most of the mission at low altitude to avoid radar detection and air defence systems. Its major disadvantage is its slow speed (Mach 0.7), which makes for long mission times to extreme-range targets. Thus if the Russians field enough high-performance low-level detection and air defence-missile systems, and aircraft with look-down radars, then the credibility of the cruise missile in its present form becomes questionable. The Americans are actively looking at the incorporation of 'stealth' anti-radar detection technology into its next cruise-missile generation to mitigate this failing.





The basic GLCM combat unit comprises 16 missiles loaded on four TELs (transporter/erector/launchers) and two LCCs (launch control centres) for command and control.

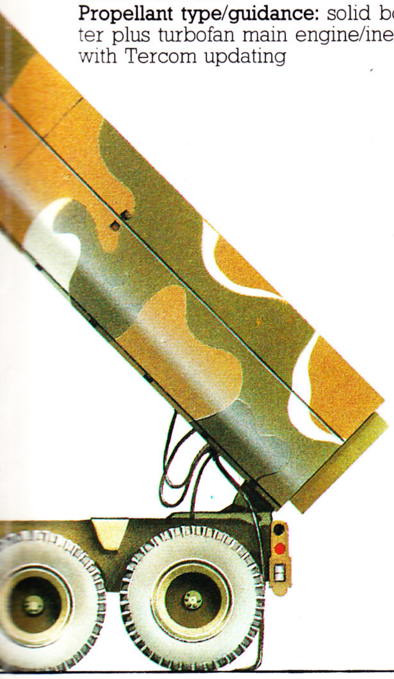




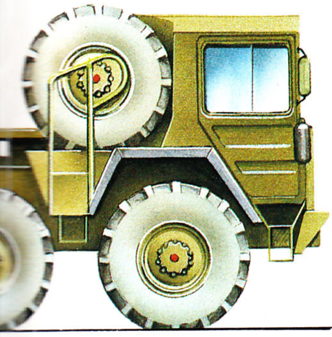
A dramatic launch picture of a GLCM during a test firing (probably at White Sands Missile Range, New Mexico). The missile is popped from its tube by a short-burn rocket, giving it enough energy to keep coasting upwards as it unfolds its wings, tail and engine inlet, and fires up the small turbojet on which it cruises.

Specification

BGM-109G Tomahawk
Length: 6.4 m (21 ft 0 in)
Diameter: 0.53 m (1 ft 8$\frac{9}{10}$ in)
Weight: 1200 kg (2,645 lb)
Warhead weight: 123 kg (270 lb)
Warhead type: 200-kiloton nuclear, and training
Minimum range: not available
Maximum range: 2780 km (1,725 miles)
CEP: 18.3 m (60 ft)
Launch vehicle: wheeled transporter-erector-launcher
Propellant type/guidance: solid booster plus turbofan main engine/inertial with Tercom updating



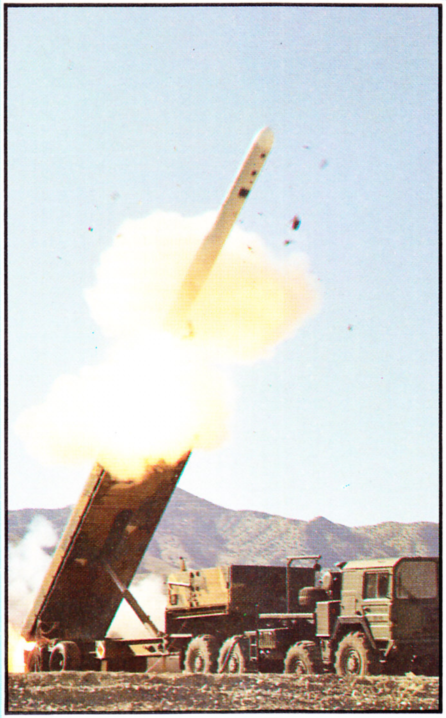
Here the TEL is shown parked in the firing mode with the quad missile box elevated. The LCC seen below contains all systems needed for a two-man crew to target and fire.

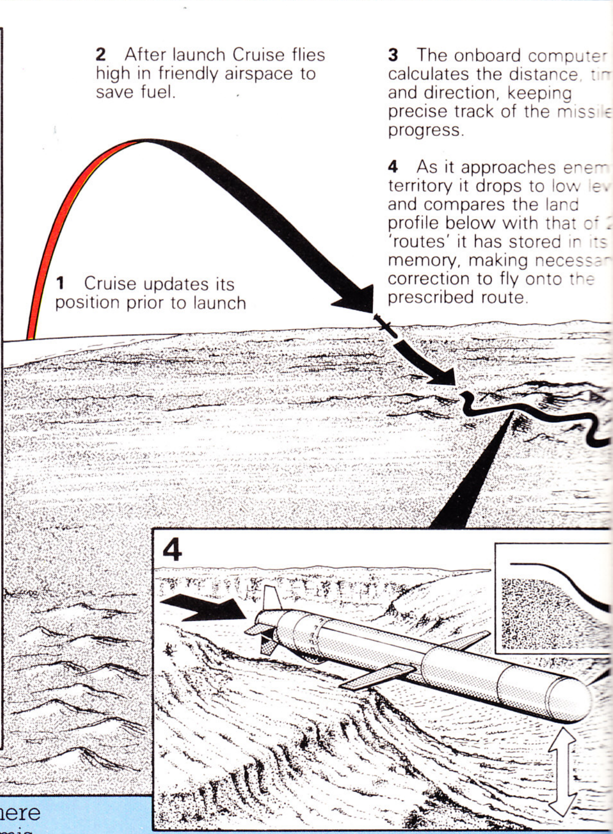


Ground-Launched Cruise in Action

With a noise like thunder, what appears to be a section of oil pipeline rises above the distant treetops at an angle of about 45° and climbs quite slowly into the sky. Suddenly the rocket, which has been noisily thrusting at the rear, falls away and plummets to the ground. Less obviously, the object is transforming itself from a piece of pipeline into a miniature aircraft, with sweptback wings, a tail and an inlet gulping air to feed a small jet engine. Pushing over into level flight it is all set for a journey taking the best part of three hours.

All over remote places in Western Europe, similar objects are thrusting obliquely upwards and setting course to the east. They hardly seem like the popular idea of missiles, for they climb away quite gently and fly off at little more than half the speed of modern fighters, in fact hardly one-third the speed that modern fighters can reach at high altitude. Neither are they difficult to see, despite their camouflage of a predominantly grey colour. Yet these toy aeroplanes have been the cause of the biggest 'peace' protests ever seen. Nobody in the West has appeared to be concerned at the vast armadas of SS-9, SS-11, SS-18 and other gigantic ballistic missiles aimed at every Western city from hardened silos deep in the USSR (and against which the West has no defence whatsoever) but thousands are vehemently eager to stop the deployment of these relatively puny slow-flying winged weapons which, if they got through, would be accurate enough to knock out the individual Russian missile silos.




2 After launch Cruise flies high in friendly airspace to save fuel.
3 The onboard computer calculates the distance, ti and direction, keeping precise track of the missil progress.
4 As it approaches enem territory it drops to low le and compares the land profile below with that of 'routes' it has stored in its memory, making necessar correction to fly onto the prescribed route.
1 Cruise updates its position prior to launch
4

On the move

Of course, if the West ever has to fire at a Soviet ICBM silo it will be too late, because the silo will already be empty. Some 350 of the Soviet long-range missiles are at this moment targeted on the 100-odd air bases available to the combat aircraft that defend Western Europe. Not one is targeted on a cruise missile base, because the whole point of this weapon is that it is mobile and at any crucial time the enemy will not know its whereabouts. In this regard the cruise missile is similar to the very much larger Russian SS-20 and the thousands of earlier FROG family rockets, 'Scud' and other mobile weapons which for many years have been familiar to the populations of the western USSR and the Warsaw Pact countries as they have ominously rumbled along roads whilst participating in what so far have been mere manoeuvres. Soon the BGM-109G cruise missiles will also be seen trundling along roads in Western Europe, but as far as possible they will keep out of sight by moving at night, because it is vital to keep secret the locations selected as their actual firing positions.

An LCC is here seen on the march as it would be in any time of crisis, following a known route as far as possible screened from aerial or satellite observation to a predetermined firing location. Nothing would be left at the only known location, the peacetime base. Thus a pre-emptive nuclear strike would have little effect.

Every missile with self-contained guidance has to know its exact position at the start of its flight. In the case of BGM-109G each launch location is pre-surveyed, so that the exact coordinates can be prepared in advance and inserted into the missile guidance system. The latter is of an unusual type which relies crucially upon the undulations in the ground over which the missile flies, and thus the missile has to know not only its launch position in the usual geographical sense but also its exact height above sea level.

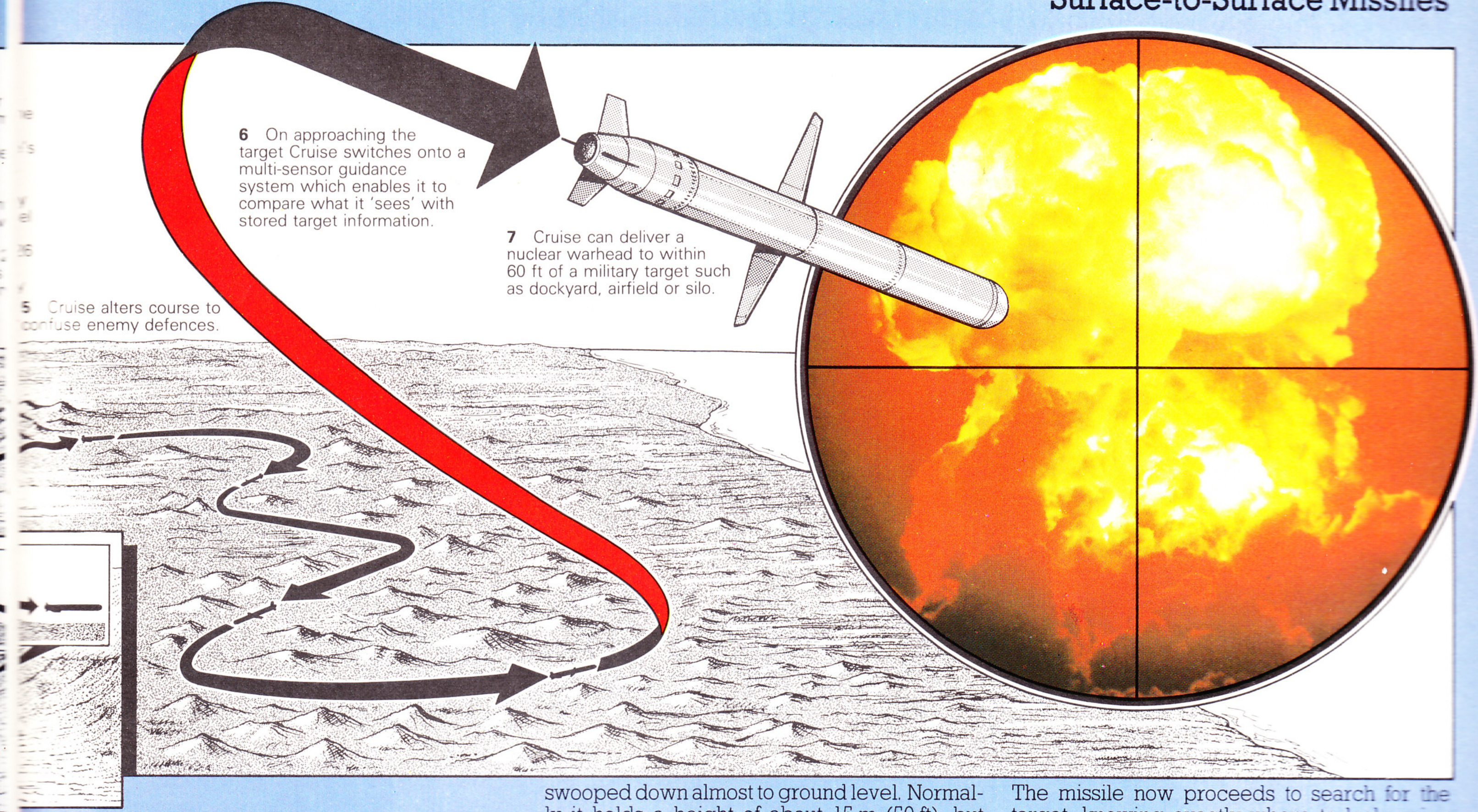
10-metre accuracy

As the missile climbs away it contains a computer in whose memory are stored all the necessary details of its launch position in three dimensions, the flight trajectory to be followed to the target, and the precise location of the target. As far as possible only pre-surveyed launch sites would be used, but it is essential to have the capability of switching to a different launch site (for example, if it is believed the original location has become known to the enemy), and from 1987 the Rockwell Collins Navstar global satellite-based positioning system will enable launch data to be entered into the missile memory within seconds of arriving at a fresh site. Navstar data are accurate to within about 10 m (33 ft), which is adequate for this missile; the numbers entered digitally into the memory include latitude, longitude, altitude, velocity within 0.01 m (4 in) per second (zero before launch, relative to the Earth's surface) and time within a few nanoseconds (thousandths of a millionth of a second).

After launch the computer automatically ticks away the metres and seconds on climb-away, whilst the vehicle changes itself from a tightly packed cylinder into a small aeroplane. The Atlantic Research or CSD rocket boost motor imparts quite gentle thrust and acceleration, and throughout the flight the environment is no more severe than in a modern fighter. Like any air-breathing aircraft, it pays to fly high in order to reduce fuel consumption, and for maximum range the high-level portion of the mission is extended as far as possible. The small Williams F107 turbofan, of 272-kg (600-lb) sea-level thrust, burns kerosene at about one-tenth the rate that an equivalent rocket would eat up its fuel, so despite the modest size of the tankage the missile can fly up to 92872 km (1,785 miles). This range is reduced if most of the trip has to be made at low level.

One has only to draw a line less than 2415 km (1,500 miles) long from the likely launch regions to see that usually the first several hundred miles can be flown with maximum fuel economy at high altitude through friendly or neutral airspace. Over this section the whole method of guidance is the self-contained inertial system, a Litton Industries P-1000 package containing super-sensitive gyros and accelerometers which sense the exact motion of the missile and continuously compute the output in terms of changed latitude and longitude from the point of launch. No radio signal is emitted, so the missile gives no warning of its approach, and though at an altitude of some 12190 m (40,000 ft) the missile can be seen by radars over 402 km (250 miles) away, it is very small and specially designed so that its appearance as seen on hostile radars (technically known as its 'radar cross-section') is minimal. It is vital that the cruise missile should as far as possible remain undetected by hostile radars, and its small size and careful shaping combine to make it very elusive.

The accuracy of an inertial system gradually falls away as time passes. A fast ballistic missile


6 On approaching the target Cruise switches onto a multi-sensor guidance system which enables it to compare what it 'sees' with stored target information.
7 Cruise can deliver a nuclear warhead to within 60 ft of a military target such as dockyard, airfield or silo.
5 Cruise alters course to confuse enemy defences.

can cover intercontinental ranges in 30 minutes, but the slow cruise missile needs several times as long to fly its much shorter distance, and after an hour or two the cumulative effect of the various errors in the inertial measurements begins to be significant. Typically, a modern inertial system might be 500 m (1,640 ft) off course after an hour, or after two hours in the case of a very good system. There are ways of checking on the missile's position as it flies across the land, and thus of updating the inertial navigation system to maintain its accuracy. The BGM-109G is equipped with an amazing new back-up system developed by McDonnell Douglas and called Tercom (Terrain comparison, or more accurately, TERrain COntour Matching). Technically known as DPW-23, this small package stores in its memory millions of figures which represent the successive heights of the ground over which the missile will fly. These measurements combine to form an exact profile of the Earth's surface, each of which is unique to a particular flight over a particular route. DPW-23 stores perhaps 25 such profiles. No matter how the inertial guidance has behaved, it will make landfall on to one of the 25 routes.

Terrain clearance

As soon as DPW-23 is switched on, a super-accurate radar altimeter begins measuring the distance vertically down to the ground, and the successive readings quickly establish which route the missile is on. The on-board computer then adjusts the flight path slightly until the missile is exactly on course, and updates the inertial system. The Tercom system keeps measuring the height of the terrain below at carefully spaced time intervals, and thus keeps updating the guidance and holding the exact desired route. What makes the process more complicated is that, to try to avoid detection by enemy radars, the missile has already swooped down almost to ground level. Normally it holds a height of about 15 m (50 ft), but crossing hills it will rise to about twice this height above the ground, and the 'terrain clearance' crossing mountains may have to be increased to 100 m (330 ft). Thus, the Tercom system's measurements of the height above the ground have to be subtracted from the known height of the missile (from air pressure or inertial measurements) to get the true undulations in the Earth's surface.

Final targeting

When the missile gets near its target it switches on yet a third guidance mode, the most accurate of all. The TCU (Terminal Correlator Unit) contains further sets of millions of numbers which in fact are a digital (numerical) representation of a detailed picture of the target. The picture shows the target as it would be seen by the approaching missile, using various visible and IR (infra-red) wavelengths. The missile now proceeds to search for the target, knowing exactly where to look, using radar, optical and IR sensors. The computer turns the picture actually seen into digital numbers and compares them with those stored in the TCU. The computer finally steers the missile to merge the two sets of numbers.

Thus, as the missile plunges down on its target, its accuracy is continuously refined by 'looking' at the target, and tests have shown that the final CEP (circular error probable) will be very unlikely to be worse than 18.3 m (60 ft). This is an unprecedented accuracy after a flight of some 2800 km (1,740 miles) in over three hours. It has so worried the Russians that the 'anti-cruise' campaign is their greatest ally.

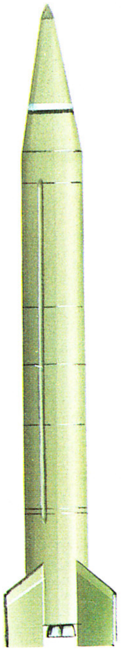
A ground launched cruise missile in flight over an American desert. Operationally the missile would fly its first few hundred miles at relatively high level to conserve fuel. From then on it would drop down to treetop height, making this small but deadly missile a highly elusive target.

USSR

SS-1 'Scud'/SS-X-23 Short Range Ballistic Missile Systems

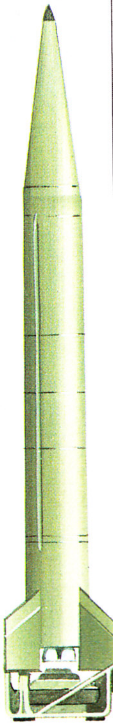
The **SS-1 'Scud'** guided missiles are classed as operational/tactical-level missile systems by the Soviets. The original 4400-kg (9,700-lb) **'Scud-A'** was first employed in 1957. Carried on a variant of the IS-III heavy tank chassis, the missile was limited to a 130-km (81-mile) range with a 40-kiloton nuclear warhead as its payload. In 1965 the improved 6370-kg (14,043-lb) **'Scud-B'** was introduced on an eight-wheeled MAZ-543 erector-launch vehicle for greater mobility. By 1970 the 'Scud-B' constituted three-quarters of the 300 'Scud' launchers deployed. Around this time the longer range **'Scud-C'** was first deployed, this being an improvement over the 'Scud-B' in terms of propellant efficiency but at the expense of a worse CEP at long ranges. By 1978 all the 520 or so 'Scud' launchers deployed in the Soviet army were carrying the 'Scud-B' or 'Scud-C' versions.

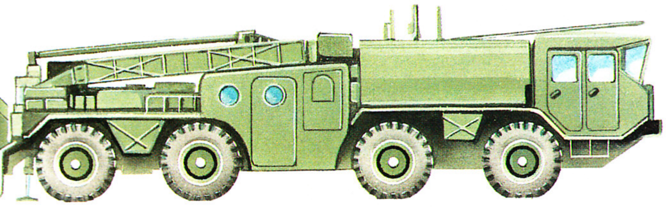
In Soviet service the 'Scud-B' and 'Scud-C' are deployed at army and army group levels in brigades consisting of a headquarters battery with three firing batteries each of three launcher vehicles and three reload vehicles carrying single missiles. Alternative 1000-kg (2,205-lb) HE or chemical warheads are available to replace the nuclear type. The 'Scud-A' and 'Scud-B' have been exported to all the Warsaw Pact nations, Egypt, Syria, Libya, Iraq and South Yemen. 'Scud-C' has been exported only to Libya, which is the largest operator of the 'Scud' outside the USSR with some 52 'Scud-B' and 'Scud-C' weapons in service by late 1982. Both Egypt and Iraq have used the 'Scud-B' in combat, Egypt firing three in the 1973 war against Israel and Iraq between five and 10 against Iran in the Gulf War. In both cases the results were not very inspiring.



SS-1 'Scud-B'

One of the earliest Soviet rocket publicity photographs was this scene showing four 'Scud-A' missiles in about 1962. Carried on a very heavy IS-3 tank chassis, 'Scud-A' was one of the largest battlefield mobile weapons with a length of 11.25 m/ 37 ft and launch weight of 4400 kg (9700 lb). Range is up to 130 km (81 miles).





Below: MAZ-543 type vehicles have been used for several types of large Soviet tactical missile, and here this vehicle is seen as the TEL (transporter/erector/launcher) in the firing position.

The replacement for 'Scud' is designated SS-X-23 by NATO. This missile has much improved reaction times over the 'Scud' and is much more accurate, with a CEP of 280 m (305 yards) at range of 440 km (273 miles) compared with 930 m (1,015 yards) for the 'Scud-B' at a range of 180 km (112 miles) and 1100 m (1,205 yards) for the 'Scud-C' at 450 km (280 miles). The warhead yield is 200 kilotons compared with the 40/100-kiloton yields of the 'Scud-B' and 'Scud-C'. Limited service introduction was in 1980 and by 1982 only 10 SS-X-23s had been deployed. The number of 'Scud-B' and 'Scud-C' missiles in service then was 550.

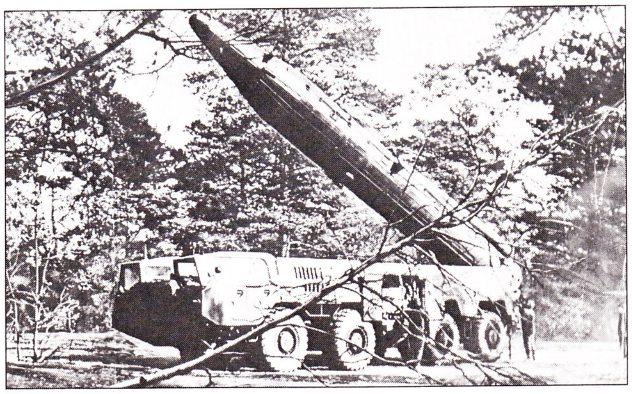
Specification
SS-1 'Scud-B'
Length: 11.4 m (37 ft 4¾ in)
Diameter: 0.84 m (2 ft 9 in)
Weight: 6370 kg (14,043 lb)
Warhead weight: 1000 kg (2,205 lb)
Warhead type: 40-/100-kiloton nuclear, HE, chemical and training
Minimum range: 80 km (50 miles)
Maximum range: 180 km (112 miles) with nuclear warhead, and 280 km (174 miles) with HE or chemical warhead
CEP: 930 m (1,015 yards) at 180 km (112 miles), reducing with further range
Launch vehicle: wheeled MAZ-537
Propellant type/guidance: liquid/inertial

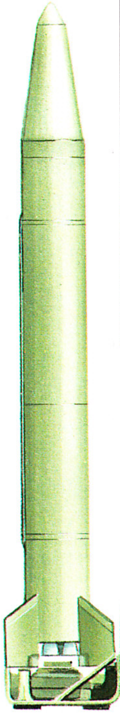
USSR

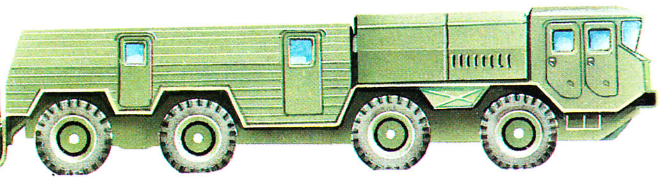
SS-12 'Scaleboard'/SS-22 Short Range Ballistic Missile Systems

The **SS-12 'Scaleboard'** was introduced into Soviet army service in 1969 as an operational/strategic-level missile system. Deployed only at army group level in brigades of one headquarters battery and three firing batteries each of three erector-launcher vehicles and three reload vehicles carrying single missiles, the 'Scaleboard' provides the Front (army group) commander with his only organic nuclear system capable of hitting both the enemy corps and army group rear areas. The only other Soviet systems tasked with strikes into the army rear areas are held by the Strategic Rocket Forces and by the Long Range Air Force. The single-stage 8800-kg (19,400-lb 'Scaleboard' is an inertially guided missile carried enclosed in a ribbed split casing on a MAZ-543 eight-wheeled vehicle similar in appearance to that carrying the 'Scud-B' and 'Scud-C' missiles. The 'Scaleboard' is elevated to the vertical from the horizontal shortly before firing. The propellant used is of the solid type, and the warhead carried has a yield of 800 kilotons. The CEP at the maximum range of 800 km (497 miles) is estimated to be 480 m (525 yards). The peak number of 'Scaleboard' missiles deployed was 120 throughout the mid-1970s. The current deployment figure is 60. A relatively rapid replacement programme by the **SS-22** started in 1977, 60 of these newer systems being deployed by 1982. The solid-propellant SS-22 has improved range, reaction time and accuracy compared with the 'Scaleboard'. A range of 880 km (547 miles) with a CEP of 320 m (350 yards) whilst carrying a 550-kiloton warhead has been indicated. The nuclear warheads for any Soviet battlefield or rear-area delivery system are stored at a separate sites heavily guarded by KGB rather than by army units. The warheads are moved before use in securely guarded vehicle convoys or by a transport helicopter with a close escort of gunship helicopters and fighter aircraft as top cover. Usually only one warhead is assigned to each of the targets on the war plan.

Specification
SS-12 'Scaleboard'
Length: 11.25 m (36 ft 11 in)
Diameter: 1.05 m (3 ft 5⅓ in)
Weight: 8800 kg (19,400 lb)
Warhead weight: 1250 kg (2,756 lb)
Warhead type: 800-kiloton nuclear
Minimum range: 220 km (138 miles)
Maximum range: 800 km (497 miles)
CEP:. 480 m (525 yards)
Launch vehicle: wheeled MAZ-537
Propellant type/guidance: solid/inertial







SS-12 is a powerful battlefield mobile weapon with a range of 800 km (500 miles). It is gradually being replaced by the SS-22, which has improved range and accuracy.

USSR

FROG series/SS-21 Tactical Surface-to-Surface Missile Systems

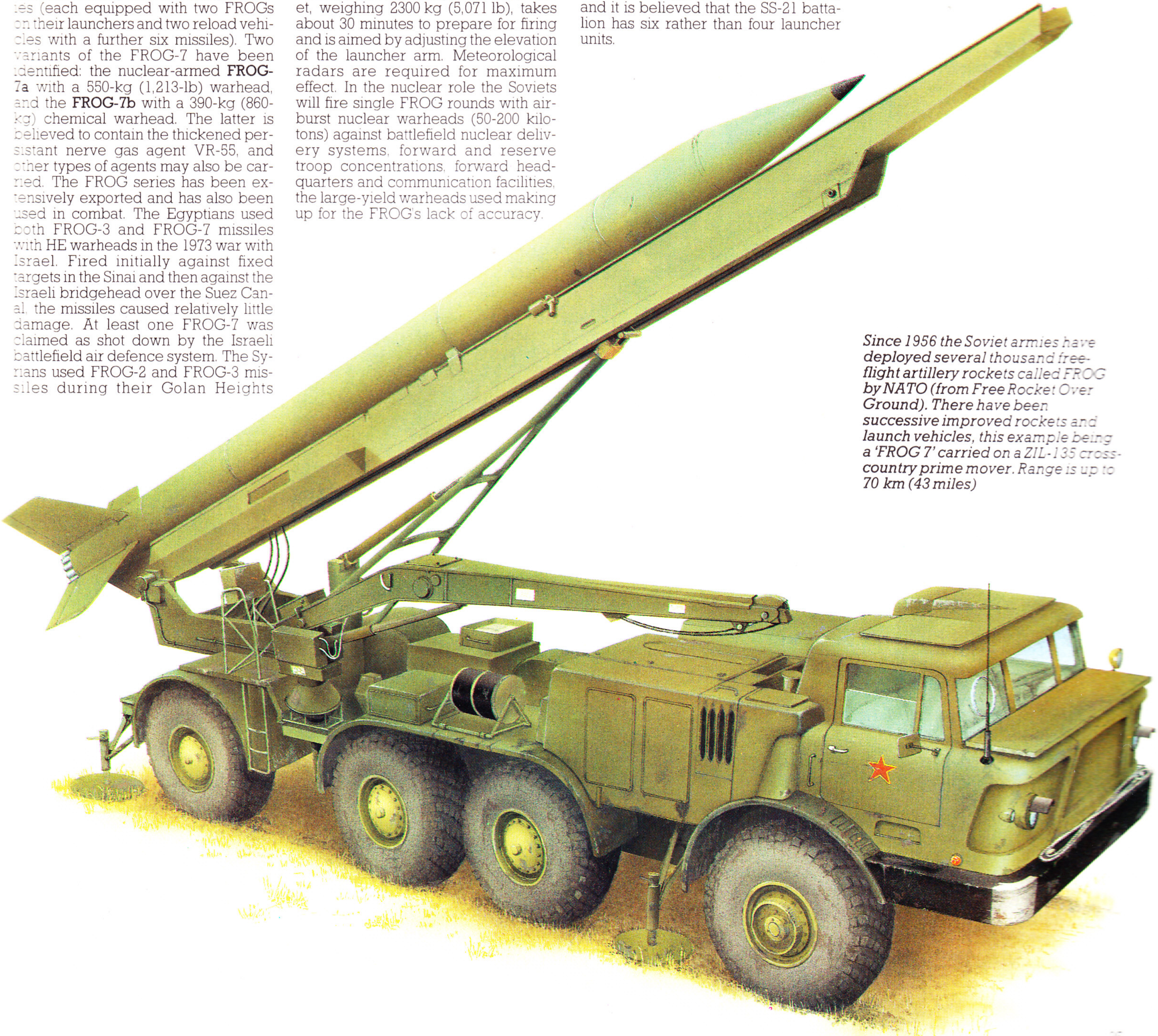
The **FROG** (Free Rocket Over Ground) missiles are described by the Russians as tactical missile systems, and are known in Soviet army service by the name **Luna**. First deployed in 1957, the FROG has undergone an extensive development programme that has resulted in seven versions of the missile, known by the NATO designations FROG-1 to FROG-7. Of these the tracked vehicle-mounted **FROG-1** to **FROG-5** are considered obsolescent, although the **FROG-3** is still used in training units and held in the Soviets reserve war stocks. The **FROG-6** is a non-operational training round, and the **FROG-7** is the current system. Introduced into service in 1965, the FROG-7 is carried on a ZIL-135 wheeled erector-launcher vehicle and is found at divisional level in both the Soviet and Warsaw Pact armies. Each tank division and motorized rifle division has a FROG battalion with a headquarters battery and two firing batteries (each equipped with two FROGs on their launchers and two reload vehicles with a further six missiles). Two variants of the FROG-7 have been identified: the nuclear-armed **FROG-7a** with a 550-kg (1,213-lb) warhead, and the **FROG-7b** with a 390-kg (860-kg) chemical warhead. The latter is believed to contain the thickened persistant nerve gas agent VR-55, and other types of agents may also be carried. The FROG series has been extensively exported and has also been used in combat. The Egyptians used both FROG-3 and FROG-7 missiles with HE warheads in the 1973 war with Israel. Fired initially against fixed targets in the Sinai and then against the Israeli bridgehead over the Suez Canal, the missiles caused relatively little damage. At least one FROG-7 was claimed as shot down by the Israeli battlefield air defence system. The Syrians used FROG-2 and FROG-3 missiles during their Golan Heights assault, but because of their inaccuracy the missiles impacted mainly on civilian areas. The most recent use of the FROG has been by Iraq against Iran in the Gulf War. Iraq has been using the FROG-7 as a long-range bombardment system targeted against Iranian cities immediately behind the battle zone. A list of current FROG operators is as follows: USSR (680 FROG-3/7), Bulgaria (36 FROG-7), East Germany (24 FROG-7), Czechoslovakia (40 FROG-3/7), Hungary (24 FROG-7), Poland (52 FROG-3/7), Romania (30 FROG-3/7), Yugoslavia (16 FROG-7), Egypt (12 FROG-7), Iraq (24 FROG-7), Kuwait (12 FROG-7), Libya (48 FROG-7), Syria (24 FROG-7), South Yemen (12 FROG-7), North Korea (54 FROG-5/7) and Cuba (50 FROG-4).

FROG-7 is a single-stage spin-stabilized solid-propellant unguided rocket that uses speed brakes as its main inflight control system. The rocket, weighing 2300 kg (5,071 lb), takes about 30 minutes to prepare for firing and is aimed by adjusting the elevation of the launcher arm. Meteorological radars are required for maximum effect. In the nuclear role the Soviets will fire single FROG rounds with air-burst nuclear warheads (50-200 kilotons) against battlefield nuclear delivery systems, forward and reserve troop concentrations, forward headquarters and communication facilities, the large-yield warheads used making up for the FROG's lack of accuracy.

The replacement for the FROG has already been fielded. Known by the NATO reporting number SS-21, the new system is believed to be similar to the American Lance in appearance and capabilities. The missile is carried on a derivative of the three-axle wheeled SA-8 'Gecko' vehicle. First deployed in 1976, the SS-21 has grown to only 30 systems by 1982. The SS-21 is a guided single-stage solid-propellant missile with improved reaction time and increased range (120 km/75 miles compared with the FROG's 70 km/43 miles). Warhead types believed to be associated with the missile include nuclear, chemical, fuel-air explosive and high explosive payloads. Maximum warhead yield has dropped to 100 kilotons because of the improvement in the CEP to 280 m (305 yards) from the FROG's maximum-range 700 m (765 yards). The alternate nuclear warhead is of 10-kiloton yield. The minimum range is said to be 14 km, and it is believed that the SS-21 battalion has six rather than four launcher units.

Specification
FROG-7

Length: 9.1 m (29 ft 10¼ in)
Diameter: 0.55 m (1 ft 9⅝ in)
Weight: 2300 kg (5,071 lb)
Warhead weight: 550-kg (1,213-lb) nuclear, 550-kg (1,213-lb) HE or 390-kg (860-lb) chemical
Warhead type: 10-, 100- and 200-kiloton nuclear, HE, chemical and training
Minimum range: 11 km (6.8 miles) nuclear and HE, and 14 km (8.7 miles) chemical
Maximum range: 70 km (43 miles)
CEP: 450–700 m (490–765 yards) depending on range
Launch vehicle: wheeled ZIL-135
Propellant type/guidance: solid/none



Since 1956 the Soviet armies have deployed several thousand free-flight artillery rockets called FROG by NATO (from Free Rocket Over Ground). There have been successive improved rockets and launch vehicles, this example being a 'FROG 7' carried on a ZIL-135 cross-country prime mover. Range is up to 70 km (43 miles)

USSR

Soviet Cruise Missile

The Russian army has at present no equivalent to the American land-based cruise missile, although it has been reliably reported that the Russians are currently in the early stages of testing such a missile with a range in the order of 2000-3000 km (1,240-1,865 miles). The missile will apparently be capable of being launched from ships, submarines, aircraft or mobile land-based launchers along the lines of the American BGM-109 Tomahawk family. Operational deployment is not thought likely until the late 1980s or early 1990s.

At present the nearest that a Soviet missile comes to the cruise missile category is the turbojet-powered **SS-C-1B 'Sepal'** assigned to the Soviet Coastal Artillery and Rocket Troops for defence of major ports and naval bases. The 'Sepal', a land based variant of the SS-N-3 'Shaddock' naval anti-ship missile, is carried on the rear of a large lengthened lorry chassis in its own cylindrical container-launcher bin, which is elevated for firing. The 'Sepal' has a secondary surface-to-surface role against land targets and can be fitted with a nuclear or a chemical warhead. In the first case the warhead can be either of 800-kiloton yield when the guidance is solely by autopilot with a mid-course guidance capability, or of 350-kiloton yield when the guidance also includes an active-radar terminal homing unit as well as the autopilot and mid-course guidance capability. The chemical warhead comes in two variants, one carrying the non-persistant blood agent hydrogen cyanide and the other filled with VR-55, which is a thickened form of the nerve gas Soman. The maximum flight altitude of the 'Sepal' is 4600 m (13,125 ft) with a maximum attained speed of Mach 1.4. This makes the missile very vulnerable to European battlefield air-defence systems although it is still a viable system in secondary battle zones. Current deployment is approximately 100 launcher-containers in battalions of 15 to 18 vehicles.

Specification

SS-C-1B 'Sepal'

Length: 10.9 m (35 ft 9 in)

Diameter: 0.86 m (2 ft 9¾ in)

Weight: 10500 kg (23,150 lb)

Warhead weight: 1000-kg (2,205-lb) nuclear, 1000-kg (2,205-lb) conventional, 1000-kg (2,205-lb) chemical and 2000-kg (4,409-lb) nuclear

Warhead types: 350-kiloton nuclear, high explosive, AC or VR-55 chemical agent, and 800-kiloton nuclear

Minimum range: 40 km (25 miles)

Maximum range: 460 km (286 miles)

CEP: 500–1000 m (545–1,190 yards) depending on guidance package used and range

Launch vehicle: lengthened wheeled lorry chassis

Propellant type/guidance: liquid/autopilot plus mid-course correction and optional active-radar terminal homing (depending on warhead choice)

USSR

SS-4 MRBM Missile System

The Soviet **SS-4** (NATO reporting name **'Sandal'**) is a development of the SS-3 'Shyster' missile. Deployed initially in 1959, the SS-4 rapidly became the standard operational/strategic-level MRBM of the Soviet Strategic Rocket Forces (Raketnyye Voyska Strategicheskovo Natnacheniya, or RVSN). In fact all Soviet land-based missiles with ranges exceeding 620 miles (1000 km) are assigned to the Strategic Rocket Forces whilst those missiles with ranges of under 620 miles (1000 km) are assigned to the Rocket Troops and Artillery branch of the Soviet army. Both the MRBM and IRBM forces are designed to deliver nuclear strikes against Western Europe, the Middle East, Japan and China. The SS-4 and SS-20 systems targets include those in the immediate enemy army group rear areas lying some 310 to 375 miles (500 to 600 km) behind the battle zone, whilst the remaining targets for the SS-4, SS-5 and SS-20 missiles lie at distances in excess of 620 miles (1000 km) and include strategic theatre headquarters and communications facilities, airfields, ports, logistical centres and selected politico-economic targets such as oil refineries.

The SS-4 gained a certain notoriety in 1962 as the main Soviet missile deployed to Cuba during the Cuban Missile Crisis. It was during this deployment that it was noticed that the guidance had been changed from command to an inertial system. The complete SS-4 firing unit consists of around one dozen tractor vehicles and associated trailers. The missile can be fired either from a fixed hardened site or from a soft launch pad. At the latter site a reload capacity is known to exist. The SS-4 force peaked at its maximum during the 1960s, but fell to 500 in the period 1971-7. From the latter year the numbers started to decline as the SS-20 was introduced until in March 1983 only some 232 were in service, based primarily in the Western Soviet states and targeted towards NATO and the Middle East. Replacement by the SS-20 continues.

The SS-4 was also developed into the **B1** small utility satellite launch-vehicle by fitting a second stage. First use of the B1 was in 1962, and the type has been used to launch Kosmos and Interkosmos series satellites from the Kapustin Yar space centre.

Specification

SS-4 'Sandal'

Length: 21.0 m (68 ft 10¾ in)

Diameter: 1.6 m (5 ft 3 in)

Weight: 27000 kg (59,525 lb)

Warhead type: single 1.2-megaton thermonuclear RV, or high explosive

Range: 2200 km (1,367 miles)

CEP: 2300 m (2,515 yards)

Launch facility: hardened silo or fixed soft launch pad

Launch: hot type (reload capability at soft site)

Propellant type/guidance: liquid/inertial

USSR

SS-5 IRBM Missile System

The Soviet **SS-5** (NATO reporting name **'Skean'**) is the operational/strategic-level IRBM single-stage successor to the SS-3 and SS-4 MRBM missiles. First deployed in 1961, the missile is similar in configuration to its predecessors but is identifiable by a lack of fins and a blunter nose cone. Normal transport is by a trailer towed by a wheeled tractor vehicle. The missile is deployed in hardened underground silos and at soft launch pad sites. The SS-5 soft sites are known to have a refire capability. The SS-5 force level peaked at its maximum in the 1960s, with a small decline to 90 for the period 1975-8. In 1979 the numbers began to drop sharply as the SS-20 reached operational units, until only 16 were in service in March 1983 with the rocket armies facing NATO. By late 1983 or early 1984 the SS-5 is expected to be phased out of service entirely.

The SS-5 has also been the subject of development as a satellite launch-vehicle. The flexible intermediate launch vehicle, coded **C1** by the Americans, is an SS-5 fitted with a restartable second stage. The C1 is thought to be 31.6 m (103 ft 8 in) long, with a diameter of 2.4 m (7 ft 10½ in), and has been used to launch Kosmos, Interkosmos, Oreol and Aryabhata series satellites from the Kapustin Yar, Plesetsk and Tyuratam space flight centres. Since its first flight in 1964 the C1 has been developed to carry multiple spacecraft payloads, initially three, then five and finally eight at a time.

Specification

SS-5 'Skean'

Length: 23.0 m (75 ft 5½ in)

Diameter: 2.4 m (7 ft 10½ in)

Weight: not available

Warhead type: single 1.2-megaton thermonuclear RV

Range: 4100 km (2,548 miles)

CEP: 1110 m (1,215 yards)

Launch facility: hardened silo or fixed soft launch pad

Launch: hot type (reload capability at soft site)

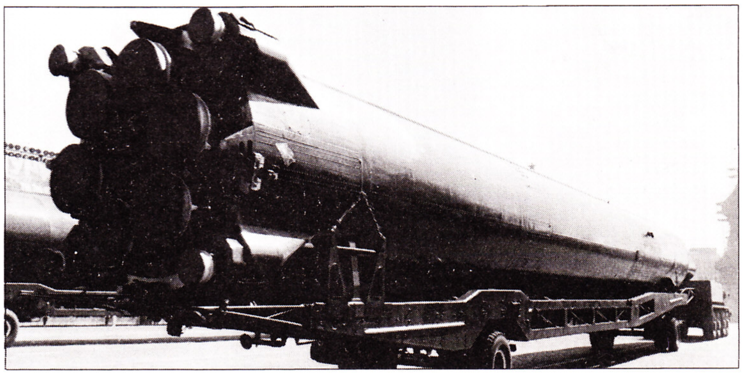
Propellant type/guidance: liquid/inertial

USSR

SS-9 Heavy ICBM Missile System

The **SS-9 heavy ICBM (NATO reporting name 'Scarp')** entered service in its initial form with the Strategic Rocket Forces in 1965 as the largest ICBM in the world. The missile was a three-stage inertially-guided liquid-propellant type. The Soviets then developed another three variants of which only one, the Model 4, actually entered service in some numbers from 1971 onwards. The **SS-9 Model 1** carried a 25-megaton warhead; the briefly-deployed **SS-9 Model 2** had a 20-megaton warhead; and the **SS-9 Model 4** had three MRVs of 3.5-megaton yield each. The **Model 3** or **F-1-m** satellite launch-vehicle version was employed as the test vehicle for a depressed trajectory role and Fractional Orbital Bombardment System (FOBS). The first flight of a FOBS missile was in 1966, the uppermost stage being a new fourth stage acting as the suborbital warhead-carrier that attained a temporary orbit close to the Earth's surface before a retro-rocket unit was activated to bring the carrier back into the atmosphere over the target zone. Such a missile can be fired in any direction to hit its target without alerting the defending early warning systems until just before impact. However, the penalty incurred is a reduction in accuracy that is offset somewhat by the high-yield multi-megaton warhead carried. A three-stage FOBS variant is also believed to have been developed, possibly using the uppermost stage of the SS-10 'Scrag' ICBM for the suborbital warhead carrier. The FOBS test flights lasted until 1971.

All the SS-9 ICBM variants can loosely be described as bottle-shaped in appearance with the first stage having six fixed thrust nozzles and four vernier nozzles. The SS-9 Model 3 has also appeared in the **F-1-r** satellite launcher form. This is the main Soviet anti-satellite hunter/killer missile and carries a manoeuvring final stage with multiple-burn capacity to attack US near-Earth orbit reconnaissance and communications satellites by detonating an onboard high explosive frag-



First of the really global missiles to be deployed in substantial numbers, SS-9 is 345 m (113 ft) long and has a launch weight of 200 tonnes. This version, seen on parade through Red Square in 1967, has a single 25-megaton warhead, by far the largest ever produced for any missile.

SS-9 Heavy ICBM Missile System (continued)

mentation charge near them.

The numbers of SS-9s deployed peaked at 308 in the period 1972-4, but declined from then as the first of the even larger SS-18 ICBMs became operational. By 1980-1 the SS-9 had been totally replaced in their silos on a one-for-one basis, although it is known that 18 launch pads remain operational at the Tyuratam space centre to launch the F-1-r. It is also likely that several F-1-m missiles remain available for use in a strategic nuclear exchange.

Specification
SS-9 'Scarp'
Length: Model 1 34.5 m (113 ft 2¼ in); Model 2 34.5 m (113 ft 2¼ in); Model 4 35.0 m (114 ft 10 in)
Diameter: 3.05 m (10 ft 0 in)
Weight: 200000 kg (440,920 lb)
Warhead type: Model 1 single 25-megaton thermonuclear; Model 2 single 20-megaton thermonuclear; Model 4 three 3.5-megaton MRVs
Range: Models 1 and 2 11000 km (6,835 miles); Model 4 12000 km (7,455 miles)
CEP: Models 1 and 2 740 m (810 yards); Model 4 1850 m (2,025 yards)
Launch facility: hardened silo
Launch: hot type
Propellant type/guidance: liquid/inertial

First of the really global missiles to be deployed in substantial numbers, the SS-9 carried either a 25-megaton warhead or three 3.5-megaton MRVs. It has now been replaced by the SS-18.

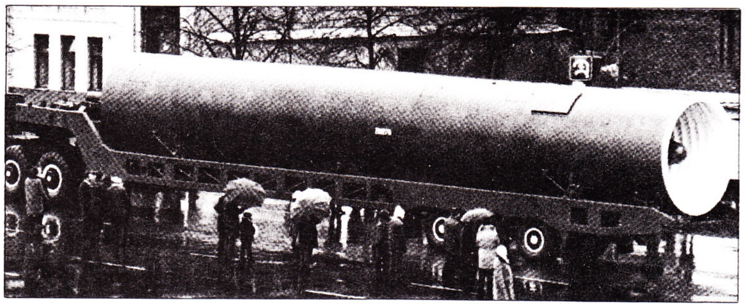
USSR

SS-11 Lightweight ICBM System

The **SS-11** (NATO reporting name 'Sego') was introduced into service in 1966. By 1970 some 970 had been deployed, making this the most numerous of all ICBMs deployed. The two-stage storable liquid-propellant missile was developed in four versions: the basic **Model 1** with a single RV, the **Model 2** first seen in the late 1960s but non-operational although fitted with a single RV and advanced penetration aids, the **Model 3** deployed in 1973 with three MRVs, and the **Model 4** seen in the late 1970s with three or six small MIRVs but not deployed operationally.

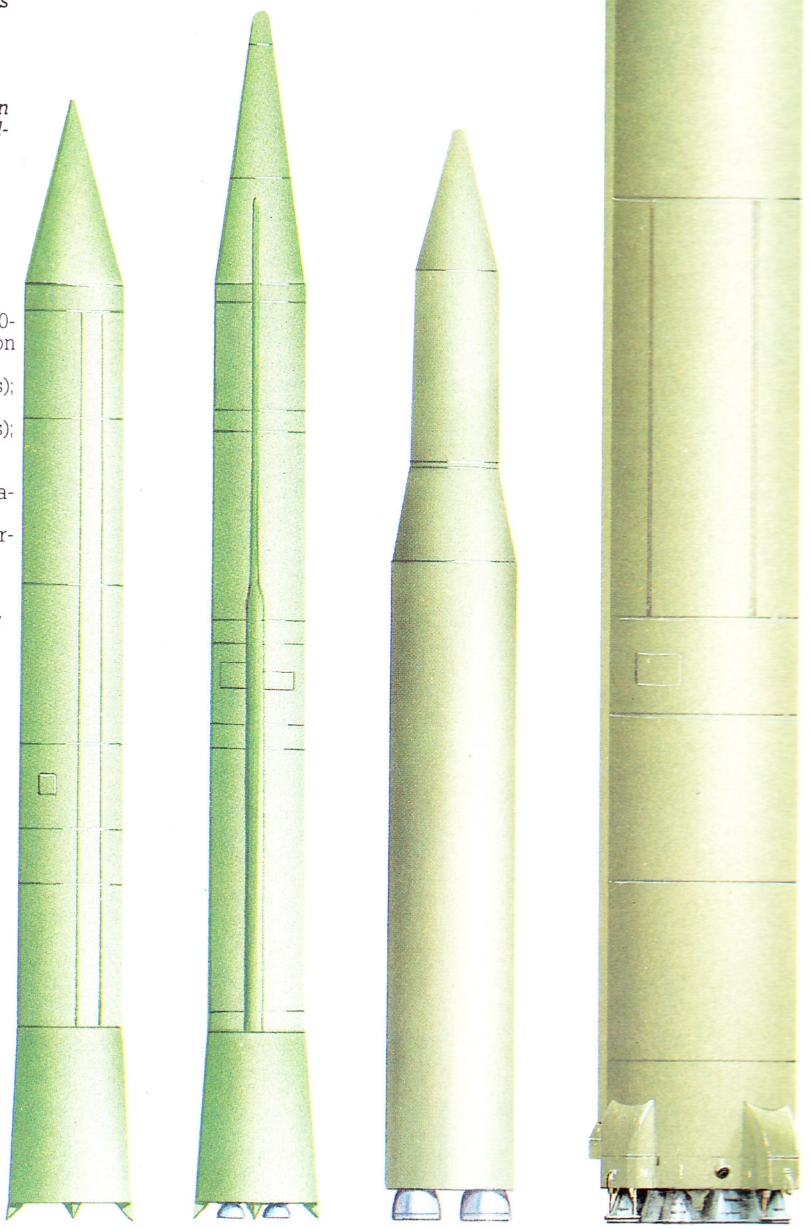
By 1975 the number of the deployed SS-11 Model 1 and Model 3 variants dropped slightly to 960 as the first of the SS-17 and SS-19 replacement systems were fielded. By 1977 the number had dropped to 850 and then by 1979 to 650. By mid-1982 the number had stabilized at around 570 with only a small number believed to be of the Model 3 type. In March 1983 the number had dropped to 550 as the first 20 of an additional 50 MIRVed SS-19 Model 3s were deployed to suitable SS-11 silos. By the mid-1980s the Soviets will have completed their present ICBM modernization programme and will have a total of 520 SS-11, 60 SS-13, 150 SS-17, 308 SS-18 and 360 SS-19 third- and fourth-generation ICBMs in service. The SS-11 has been identified at the following missile field locations: Derazhnya, Kozelek, Teykovo, Kostroma, Perm, Gladkaya, Drovyanava, Olovyannaya and Svobodnyy.

The SS-11 has been periodically shown in the Moscow military parades but only enclosed in a tubular container carried on the rear of a wheeled tractor-trailer combination. The only physical features of the missile to be seen are four thrust nozzles on the first stage and the tip of the nose cone. The container is believed to be raised to the vertical over a silo for loading. The Americans credit the SS-11 force with a limited reload capability as the hot-launched missile is accommodated within a launch container inside the silo. This and the silo design are common to the SS-11, SS-17, SS-18 and SS-19 systems, and limit damage during main-engine ignition and launch. Refurbishment and reloading probably take several days. Provision for the delivery of reserve missiles, warheads and propellants to a number of SS-11 and SS-19 hot-launch ICBM complexes, together with all the cold-launch SS-17 and SS-18 missiles, is known to exist. None of the extra missiles or warheads is reckoned under the SALT agreements, only the launchers being counted.



We in the West still have only a rough idea of what SS-11 looks like, but this is the missile that has since 1966 increasingly been targeted on every city, airfield and port in Western Europe. By 1972 there were 970 known SS-11 silos, with 66 more then being built. Over 1,000 are still available, each with three 300-kiloton heads.

Specification
SS-11 'Sego'
Length: 20.0 m (65 ft 7⅓)
Diameter: 2.5 m (8 ft 2½ in)
Weight: 45000 kg (99,205 lb)
Warhead type: Model 1 single 950-kiloton RV; Model 3 three 250-kiloton MRVs
Range: Model 1 8800 km (5,470 miles); Model 3 9600 km (5,965 miles)
CEP: Model 1 1400 m (1,530 yards); Model 3 1110 m (1,215 yards)
Launch facility: hardened silo
Launch: hot type (limited reload capability)
Propellant type/guidance: liquid/inertial



Pictured from left to right:
SS-4 was operational in 1959 but has been superseded by SS-20.
SS-5, next generation missile, deployed from 1961. Rapidly being replaced by SS-20.
SS-11, first deployed in 1966, at one time the most numerous ICBM with almost 1000 in place.
SS-9, once the largest ICBM, now replaced by the even larger SS-18.

USSR

SS-13 and SS-16 Lightweight ICBM Missile Systems

The **SS-13** and **SS-16** are the first solid-propellant ICBMs to have been developed by the Soviets probably by the VN Nadradze missile design bureau that specializes in such solid-fuel missiles. The SS-13 (NATO reporting name **'Savage'**) was first deployed in 1969, although it was actually first seen in public in 1965. By 1970 the number deployed operationally had risen to 20, with 40 operational in 1971 and the maximum 60 the following year. The SS-13 is deployed in the Yoshkar Ola missile field. The 60 missiles are certain to serve into the late 1980s before replacement is undertaken. The three-stage inertially-guided missile is stated to be comparable with the Minuteman missile in terms of performance and capabilities. The upper two stages of the SS-13 were used in the development of the **SS-14 'Scapegoat'** mobile IRBM system.

In 1978 the second-generation ICBM due to be the SS-13's replacement is stated to have attained operational status after evaluation between 1972 and 1975. This missile, the SS-16 (Soviet designation **RS-14**), was not subsequently deployed, although some 60 were built. The three-stage SS-16 has an advanced guidance system believed to be of the stellar-inertial type, and a post-boost bus vehicle usually associated with MIRVs. However, the missile carries only a single RV. The SS-16 is considered to be launchable from either a silo or a mobile tractor-erector-launcher vehicle, most American defence sources tending to support the latter. No reload capability for the system is believed to exist. The upper two stages of the SS-16 have been used to form the SS-20 mobile IRBM missile.

Specification
SS-13

Length: 20.0 m (65 ft 7⅓ in)

Diameter: 1.7 m (5 ft 7 in)

Weight: 34000 kg (74,955 lb)

Warhead type: single 600-kiloton RV

Range: 8000 km (4,970 miles)

CEP: 1850 m (2,025 yards)

Launch facility: silo

Launch: hot type

Propellant type/guidance: solid/inertial

Specification
SS-16

Length: 20.5 m (67 ft 3 in)

Diameter: 1.7 m (5 ft 7 in)

Weight: 36000 kg (79,365 lb)

Warhead type: single 650-kiloton RV

Range: 8750 km (5,435 miles)

CEP: 1480 m (525 yards)

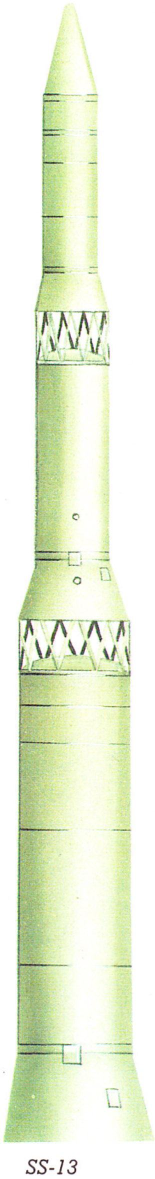
Launch facility: silo or mobile launcher

Launch: hot type

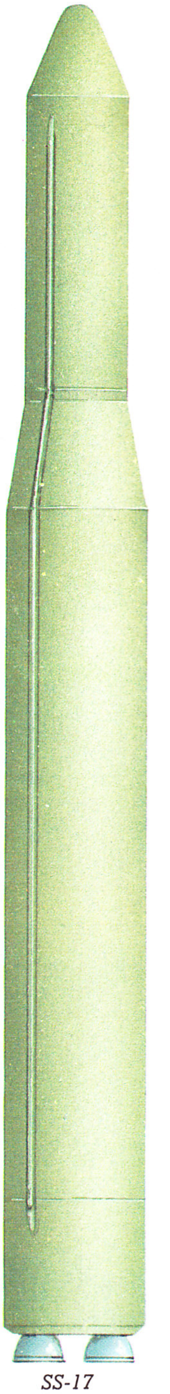
Propellant type/guidance: solid/stellar-inertial

Only a few (about 60) were put into service of the SS-13, the first of the Soviet Union's solid-propellant strategic missiles. Smaller than SS-11, it is very like a Minuteman III, and has a launch weight of 34 tonnes and range of over 8000 km (5,000 miles), usually carrying a warhead of 600-kt yield.

Right: SS-17, an accurate ICBM which replaces some older SS-11 missiles.



SS-13



SS-17

USSR

SS-17 Lightweight ICBM Missile System

The **SS-17** Soviet designation **RS-16**) was first deployed in 1975 as the second two-stage storable liquid-propellant successor to part of the SS-11 'Sego' force, the other part being the SS-19. The SS-17 is slightly longer than the SS-11 and has an increased volume. The most important features, however, are its cold-launch technique and, in its **Model 1** and **Model 3** forms, the four-MIRV warhead it carries. The **Model 2** introduced in 1977 has a single medium-yield thermonuclear warhead, whilst the Model 3 was introduced in the early 1980s because of its increased accuracy over the Model 1 version. The number of the different versions fielded was 20 Model 2 plus 130 Model 1 and Model 3 ICBMs in mid-1983. No further upgrading of the SS-17 force is envisaged for the foreseeable future. Two missile fields contain the SS-17: Yedrovo and Kostroma.

The accuracy of the force makes feasible attacks on some hardened American targets. The use of the MIRVed warhead allows a single Model 1 or Model 3 missile to attack individual targets throughout an area covering several tens of thousands of square miles, whereas the older Soviet SS-11s equipped with MRVs can only attack a single target within a few thousand square kilometres by creating a nuclear explosion 'footprint' around it with its warheads to maximize the blast and radiation damage. The SS-17 has yet to appear at a Moscow parade.

Specification
SS-17

Length: 24.0 m (78 ft 9 in)

Diameter: 2.5 m (8 ft 2½ in)

Weight: 65000 kg (143,300 lb)

Warhead type: Model 1 four 750-kiloton MIRVs; Model 2 single 6-megaton thermonuclear RV; Model 3 four 750-kiloton MIRVs

Range: Model 1 10000 km (6,215 miles), Model 2 11000 km (6,835 miles); Model 3 10000 km (6,215 miles)

CEP: Model 1 440 m (480 yards); Model 2 425 m (465 yards); Model 3 350 m (385 yards)

Launch facility: hardened silo

Launch: cold type (confirmed reload capability)

Propellant type/guidance: liquid/inertial.

USSR

SS-18 Heavy ICBM Missile System

The **SS-18** heavy ICBM (Soviet designation **RS-20**) entered service in its initial form in 1974. Since then three other versions have been deployed, the **Model 2** in 1976, the **Model 3** in 1977 and the **Model 4** in 1979. By 1980-1 the four versions had replaced the 308 SS-9 missiles. In mid-1982 the number breakdown for the four versions was: Models 1 and 3 total 26, Model 2 total 162 and Model 4 total 120. In 1983 it was learnt that the Model 4 was continuing to replace the Model 2 in a progressive upgrading of the SS-18 force. The Model 1 carries a single 27-megaton warhead, whilst the longer-range and improved-accuracy Model 3 carries a single 20-megaton warhead. The Model 2 has a spin-stabilized computer-controlled warhead bus carrying 8 to 10 900-kiloton yield MIRVs. The later Model 4 is also MIRVed but carries up to 14 warheads (usually 10 500-kiloton MIRVs and four dummies plus other advanced penetration aids). The SS-18 Models 3 and 4, together with the most accurate version of the SS-19, can destroy hard targets. This effectively means the American Minuteman ICBM force in its silos. Hence the Soviets have a credible first-strike capability if they require it. The very high yield SS-18 Models 1 and 3 also maintain the Russian preference for such warheads, the accuracy of both being sufficient to allow the missiles to engage the deeply buried and nuclear hardened American Strategic Air Command command, control and communication facilities that will be used in the event of a nuclear conflict.

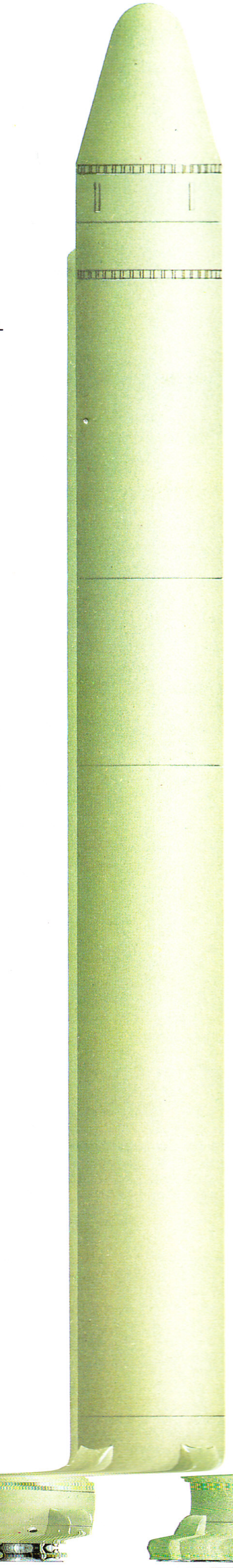
The SS-18 is a cold-launched two-stage liquid-propellant missile. The launch technique is so called because the missile is ejected from its silo by a gas generator system before the main engines are fired. This allows the silo to be reused within a day or so after the missile has been fired. The Russians have been monitored doing this during Strategic Rocket Force exercises. The reload capability is of significant importance to the Russians in their protracted nuclear-exchange warfighting scenario. The SS-18 missile fields are known to be located in the following areas: Kartaly, Dombarovskiy, Imeni Gastello, Aleysk, Zhangiz Tobe and Uzhur.

Specification
SS-18

Length: 35.0 m (114 ft 10 in)

SS-18 Heavy ICBM Missile System (continued)

Diameter: 3.0 m (9 ft 10 in)
Weight: 225000 kg (496,030 lb)
Warhead type: Model single 27-megaton RV; Model 2 8-10 900-kiloton MIRVs; Model 3 single 20-megaton RV; Model 4 10 500-kiloton MIRVs
Range: Model 1 12000 km (7,455 miles); Model 2 11000 km (6,835 miles); Model 3 16000 km (9,940 miles); Model 4 11000 km (6,835 miles)
CEP: Model 1 425 m (465 yards); Model 2 425 m (465 yards); Model 3 350 m (385 yards); Model 4 260 m (285 yards)
Launch facility: hardened silo
Launch: cold type (confirmed reload capability)
Propellant type/guidance: liquid/inertial



Left: The West was deeply concerned at the entry into service in 1965 of the gigantic SS-9, but from 1974 even greater fear has been caused by the terrifying SS-18, the largest missile ever deployed. The SALT I terms allowed deployment of 310 of these colossal weapons in several different versions.

USSR

SS-19 Lightweight ICBM Missile System

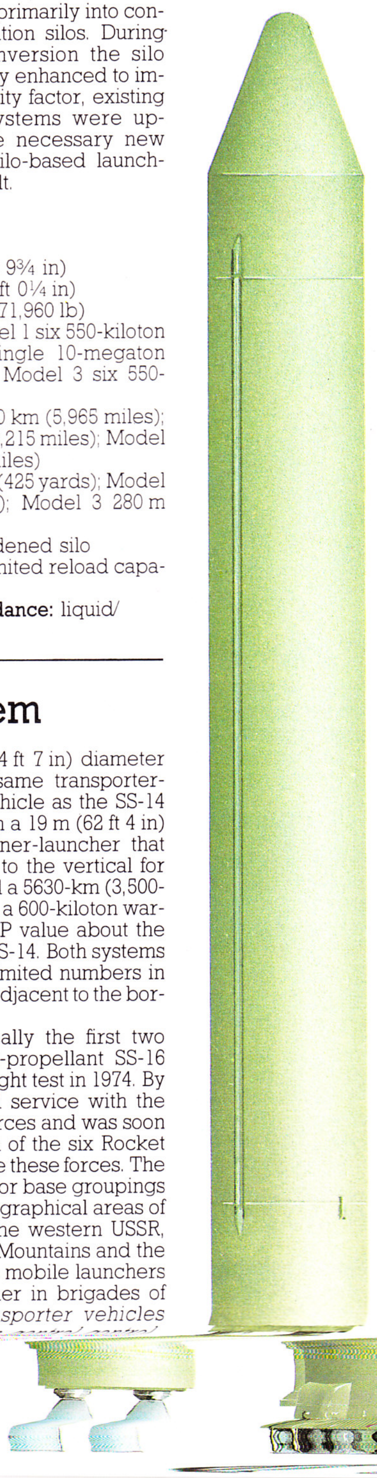
The **SS-19** (Soviet designation **RS-18**) entered service in 1975 as the first of the SS-11 'Sego' replacements, the other being the SS-17. The SS-19 is a two-stage liquid-propellant missile with an onboard computer, a MIRV payload and a combined 'fly-the-wire' inertial guidance system similar to that fitted on the SS-17 and SS-18 missiles. The computer determines the deviations from the preprogrammed course and either corrects it or computes a new course if the circumstances require it. The SS-19 is slightly larger than the SS-17 and has been fielded in three versions: the basic **Model 1** with six MIRVs, the **Model 2** (deployed in 1978) with a single high-yield thermonuclear warhead, and the improved-accuracy **Model 3** (introduced in 1980) with the same MIRV payload as the original version. In 1981 the numbers of each version deployed were 180 Model 1, 40 Model 2 and 80 Model 3 ICBMs. By 1982 the Model 3 total had risen to 90 and in March 1983 the totals were 180 Model 1, 80 Model 2 and 110 Model 3 missiles. A further 30 Model 3s will be deployed to replace SS-11 'Sego' systems by 1985 to give a final SS-19 force level of 360. The SS-19 missile fields are located in the Derazhnyna, Kozelsk, Pervomayek and Tatischchevo areas.

Because of its accuracy, the Model 3 together with the most accurate versions of the SS-18 are considered to be counterforce weapons capable of destroying practically all the American hardened missile silos by using a two warhead-to-one silo ratio.

The Soviets in their weapon improvement programmes follow an incremental policy: they improve those components of the system that require improving whilst retaining those portions that have demonstrated their reliability to a satisfactory level. For the current ICBM force this policy has meant a considerable improvement in both its reliability and capabilities. The fourth-generation SS-17, SS-18 and SS-19 deployment was primarily into converted third-generation silos. During the process of conversion the silo hardness was greatly enhanced to improve the survivability factor, existing communications systems were upgraded and where necessary new ones added, and silo-based launch-control facilities built.

Specification

SS-19
Length: 22.5 m (73 ft 9¾ in)
Diameter: 2.75 m (9 ft 0¼ in)
Weight: 78000 kg (171,960 lb)
Warhead type: Model 1 six 550-kiloton MIRVs; Model 2 single 10-megaton thermonuclear RV; Model 3 six 550-kiloton MIRVs
Range: Model 1 9600 km (5,965 miles); Model 2 10000 km (6,215 miles); Model 3 10000 km (6,215 miles)
CEP: Model 1 390 m (425 yards); Model 2 260 m (285 yards); Model 3 280 m (305 yards)
Launch facility: hardened silo
Launch: hot type (limited reload capability)
Propellant type/guidance: liquid/inertial



Below: SS-19 was deployed first in 1975, along with SS-17. Both are intended as replacements for SS-11, and are among the most accurate of Soviet ICBMs.

USSR

SS-20 Mobile IRBM System

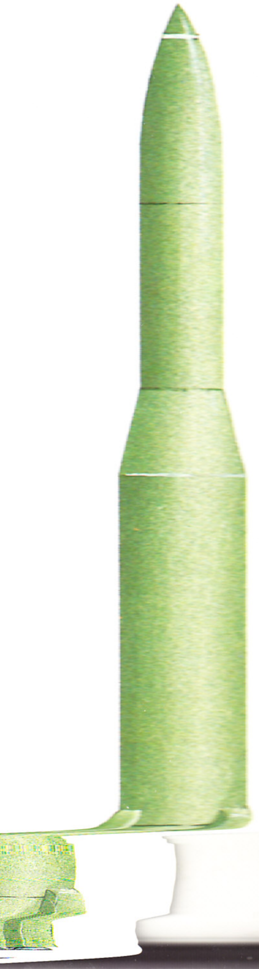
Design of the operational/strategic-level mobile **SS-20** IRBM system began in about 1967 as the long-term replacement for the SS-4 and SS-5 missiles. The SS-20 programme was allocated to the VN Nadradze design bureau, which specializes in building solid-propellant missiles. The design bureau had already some experience in developing mobile IRBM systems as the briefly deployed **SS-14 'Scapegoat'** and **SS-15 'Scrooge'** IRBM systems showed. The SS-14, carried in a container nicknamed the 'Iron Maiden' was deployed on a considerably modified IS-III heavy tank chassis that served as the transporter-erector-launcher vehicle. The whole system was known by the NATO reporting name **'Scamp'**. The 10.7 m (35 ft 1¼ in) long, 1.5 m (4 ft 7 in) diameter missile was inertially guided, had a maximum range of 3540 km (2,200 miles) and carried a 600-kiloton yield warhead. The CEP value was around 1800 m (1,970 yards). The 'Scapegoat' was basically *the first two stages of the SS-13 solid-*

ICBM. The 18.3 m (60 ft

0⅓ in) long, 1.4 m (4 ft 7 in) diameter SS-15 utilized the same transporter-erector-launcher vehicle as the SS-14 but was contained in a 19 m (62 ft 4 in) long tubular container-launcher that had to be elevated to the vertical for firing. The SS-15 had a 5630-km (3,500-mile) range, carried a 600-kiloton warhead and had a CEP value about the same as that of the SS-14. Both systems were deployed in limited numbers in Soviet Central Asia adjacent to the border with China.

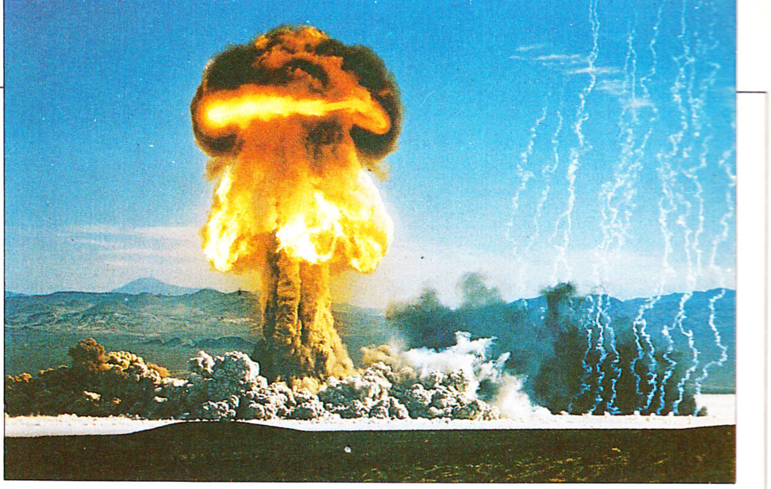
The SS-20, basically the first two stages of the solid-propellant SS-16 ICBM, had its first flight test in 1974. By 1977 it had entered service with the Strategic Rocket Forces and was soon deployed with each of the six Rocket Armies that compose these forces. The SS-20s are in six major base groupings located in three geographical areas of the USSR, namely the western USSR, just east of the Ural Mountains and the Soviet Far East. The mobile launchers are grouped together in brigades of *nine launcher-transporter vehicles* that are situated at a central control

stages of the SS-13 solid-
grouped together in brigades of
nine launcher-transporter vehicles



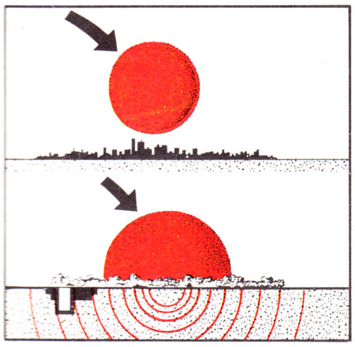
Below: SS-20 is one of the smallest of the vast array of rockets deployed by the RVSN (Soviet strategic rocket forces), but it has been much discussed in Western media apparently because it is highly mobile and easy to conceal. With three 150-kt warheads the range is about 4700 km (3,542 miles), covering all Europe.

ICBM Nuclear Warhead Development



There was a time when threatened nuclear force seemed to consist of a single blunt instrument of undeniable devastation. But defence strategists and scientists have now developed a range of warheads, and methods of delivery which have greatly complicated the discussions of nuclear comparability and security.

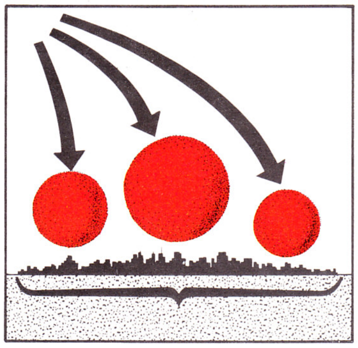
The original ICBM single re-entry vehicle (SRV) was a large-yield relatively inaccurate warhead designed to be used against large-scale area targets such as cities or industrial areas. Its capacity to devastate such targets lay principally in its blast effect, which is normally measured in pounds per square inch (psi) overpressure (i.e. pressure greater than normal atmospheric). Such warheads would almost certainly be detonated in the air above the target to give what is known as an air-burst explosion. With the advent of better guidance systems terminal accuracy increased and this allowed the large-yield warheads to be retargeted as ground-burst weapons against point targets such as the enemy's military and political strategic command, control and communications (C^3) facilities located in deeply buried and hardened underground bunker complexes. Destruction of some or all of these facilities would cause considerable confusion and delay to the opposing side in any nuclear exchange until new lines of command and control could be activated.



Single Re-entry Vehicles (SRVs). Early generation single warheads airburst over their targets to achieve devastation by blast. Later more accurate warheads were designed to groundburst against hardened targets, such as silos or command bunkers.

Both the USA and USSR currently have ICBMs fitted with thermonuclear warheads of sufficient accuracy to achieve these results.

The attacks against soft city, industrial and military targets were then, in the case of the Soviet ICBM force, assigned to the models equipped with a multiple re-entry vehicle (MRV) package as the payload. This effectively provides for landing several warheads, usually two or three, which have separated in the final stage of the flight in the same area as the target to maximize the blast damage caused; the resulting pattern of nuclear explosions is known as the nuclear footprint. The USA deployed this type of warhead only on its Polaris submarine-launched ballistic missile force and did not use it on any ICBM.

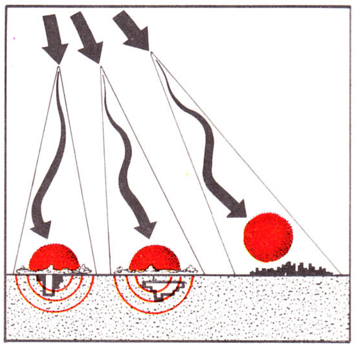


Multiple Re-entry Vehicles (MRVs). Each missile could deliver a number of warheads (usually three) whose combined airburst footprint could obliterate a city.

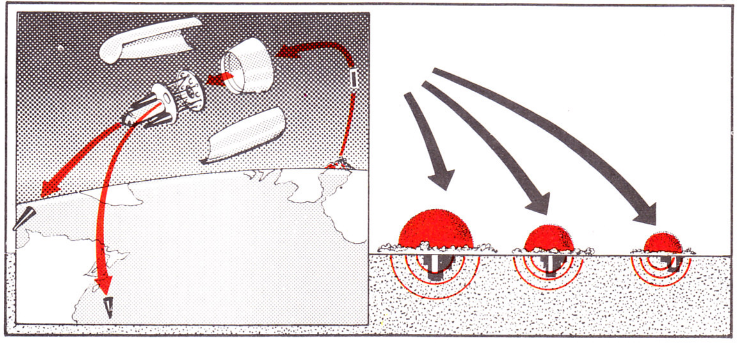
The USA decided to field the multiple independently-targeted re-entry vehicle (MIRV) warhead system instead. The MIRV is highly accurate and independently targeted, which means that each MIRV-equipped missile can engage a number of widely separated targets equivalent to the number of MIRV warheads it carries. The accuracy of the MIRV is usually sufficient for the carrying missile to be targeted against the enemy's hardened missile silos. Usually two warheads are assigned from different missiles in a cross-targeting technique in order to ensure that the kill probability approaches the certainty value. Both the Soviets and the Americans use MIRV-equipped ICBMs. The current Soviet SS-18 Model 4 and SS-19 Model 3 MIRVed ICBMs are considered to be the world's most lethal missiles in terms of accuracy, and given the numbers deployed the Russians can destroy most of the American Minuteman ICBM force in their silos by expending only a fraction of the warheads they carry for a first-strike situation.

The Americans, however, have developed a follow-on to the MIRV. This is known as the manoeuvring re-entry vehicle (MARV), and is capable both of inflight manoeuvring to avoid anti-missile defences and of terminal in-atmosphere guidance to give very low CEP (circular error probable, a measure of statistical accuracy) values in the order of tens of mentres. The technology for the MARV is available for eventual deployment on all American strategic ballistic missile systems if required.

The Americans also have available the technology of the Pershing II earth-penetrator theatre nuclear missile warheads. If the Americans were to combine the low-yield earth-penetrator design with MARV technology then the possibility is opened up of the eventual deployment of an ICBM carrying a large number (20 or more) of super-accurate warheads capable of attacking any type of target. Such a development would have a considerable effect on the strategic forces of both sides as a radical rethinking of fixed-base missiles and command facilities would have to be undertaken.



Manoeuvrable Re-entry Vehicles (MARVs). Each warhead has an ability to manoeuvre itself through defences and onto its assigned target.



Multiple Independently-targeted Re-entry Vehicles (MIRVs). The independent accurate targeting of a number of warheads enables MIRVs to be groundburst against hardened targets.

SS-20 continued

and maintenance base. As in the case of the American ground-launched cruise missile, the launchers would in times of imminent conflict move by road to widely dispersed presurveyed launch sites to ensure the minimum error in the inertial guidance launch co-ordinates.

Each SS-20 is carried on the rear of a wheeled vehicle in a tubular container that has to be elevated to the vertical for firing. Three other wheeled vehicles complete the SS-20 system, one carrying a reload round whilst the other two carry the launch control, test, generators and communication systems. By July 1981 the number of SS-20 systems deployed was about 250 (175 of which were targeted against NATO nations). In mid-March 1983 the number had risen to more than 330, of which some 220 were targeted against NATO. The Russians are also known to be developing an SS-20 follow-on for service in the late 1980s or early 1990s. This has been tentatively identified as the **SS-X-28** IRBM system.

Specification

SS-20

Length: 16.0 m (52 ft 6 in)

Diameter: 1.7 m (5 ft 7 in)

Weight: 25000 kg (55,115 lb)

Warhead type: Model 1 single 650-kiloton nuclear RV; Model 2 three 150-kiloton nuclear MIRVs; Model 3 single 50-kiloton nuclear RV

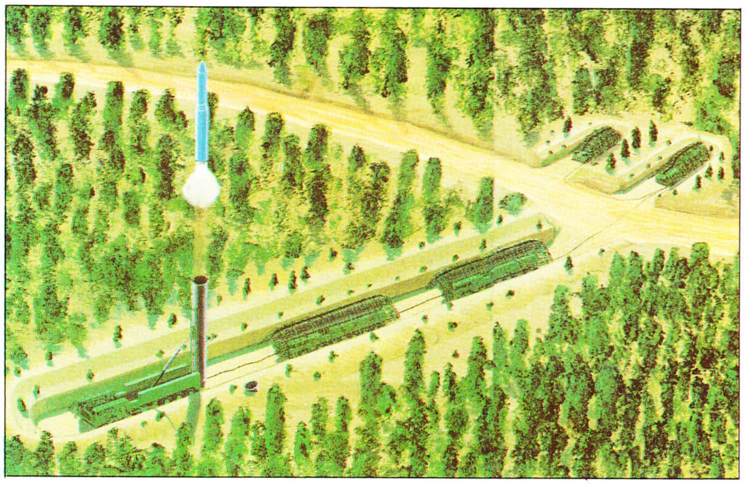
Range: Model 1 5000 km (3,105 miles); Model 2 5000 km (3,105 miles); Model 3 7000 km (4,350 miles)

CEP: 425 m (465 yards)

Launch facility: wheeled transporter-erector-launcher

Launch: cold type (reload capability confirmed)

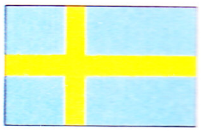
Propellant type/guidance: solid/inertial



SS-20 is being deployed in increasing numbers in Europe and the Far East. The US Department of Defense visualizes highly mobile units operating from easily prepared concealed positions, as shown here.

Armed Forces of the World

Sweden



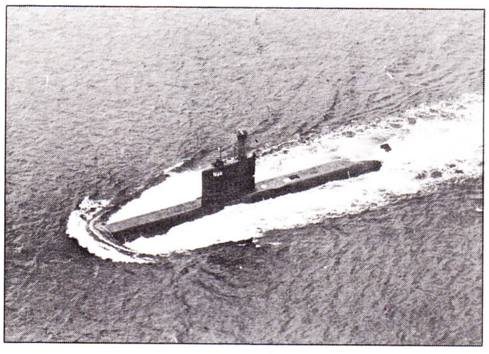
Proportionally, Sweden is one of the most highly-taxed nations on Earth, and a great proportion of the revenue is spent on defence. Sweden is not a member of NATO but has a border with the USSR, and the terrain forms a useful method of entry to both Norway and the Baltic to the south. The country has rich mineral resources but the terrain is hostile to both attackers and defenders alike, and for much of the year the climate is cold to an extreme and wet for much of the rest. To maintain their neutrality the Swedes use a combination of conscription followed by recall to the forces at intervals, coupled with a well-trained and well established system of Home Guards and local defence units. Sweden has a strong armaments industry which supplies almost all its armed forces' equipment.

The amphibious, tracked Bv 202 weighs 3.2 tons and can tow up to 15 soldiers on skis or bicycles. In a northern country like Sweden, such vehicles are essential in providing cross-country mobility in winter. The Bv 202 is now being replaced by the Bv 206, which has a much larger load capacity.

The army

The army maintains only a small cadre of about 9,000 regulars, who are used to train the 36,000 or so conscripts who pass through their hands at any one time. To train this flow of recruits the army maintains about 50 training establishments for all arms of the force, and large and well-protected depots full of equipment ready for use. In an emergency the army could suddenly be expanded to no less than 700,000 men, with a further 100,000 men turning out for Home Guard duties. To these would be added about 100 independent infantry battalions, between 400 and 500 independent companies and a large number of more Home Guard units all operating under the general control of 26 Local Defence Districts.

To maintain supplies in an emergency the Swedes make much use of their own industrial resources for arms production, and many of their weapons bear comparison with anything produced elsewhere. Although the bulk of the five armoured brigades that would be formed on mobilization are made up from Centurion MBTs, the army also has about 330 Strv-105MBTs and about 200 Ikv-91 infantry support tanks. To these can be added large numbers of Pbv-302 APCs and a wide array of towed and self-propelled artillery. Some of the towed artillery is still effective but of some vintage, and a programme of replacement by the Bofors 155 mm FH-77A is now well advanced. Anti-tank missiles are widely used, with large numbers of TOW anti-tank missiles in use and on order with large quantities of the new Bofors BILL missile in prospect for the infantry. Mortars of all calibres are well suited to the Swedish terrain.



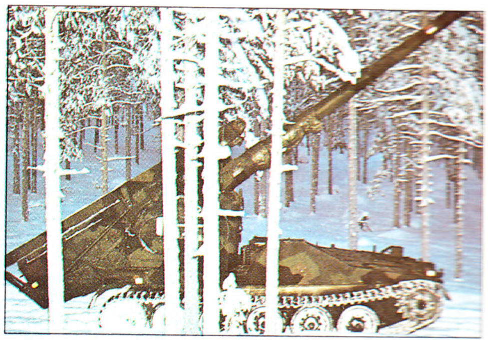
Swedish submarines are specifically designed for operation in the Baltic Sea. The Näcken, *name ship of the latest class of three boats, has a crew of only 20 due to extensive use of automation.*

Among the 19 infantry brigades that would be formed in an emergency are the four *Norrland* brigades that would be used to defend the northern areas of Sweden. These brigades are specially equipped with over-snow vehicles such as the Bv.206 and its weapon carrier variants with TOW and recoilless rifles. Some carry the Bofors RBS-70 anti-aircraft guided missile.

The only regular army unit kept in being all the time is a single army aviation battalion with about 35 helicopters including Bell AB 204 and AB 206 helicopters. Also kept in being are a further 11 army artillery aviation platoons, 66 strong in all, that are used for army liaison, artillery spotting, observation and casualty evacuation. Types in service include BAe Bulldogs, Piper Super Cubs and Dornier Do 27s.

The conscript's time with the army may vary from 7½ to 15 months, depending on the trade involved. After this period the conscript becomes an active reservist and can expect to spend some time each year with the army. On mobilization, full strengths for nearly all units can be expected within 72 hours, and to this force can be added the large numbers of Home Guard and local defence units. Taking into account the formidable Swedish terrain, it can be seen that invading Sweden would be no easy matter.

Sweden's neutrality in all matters has led to Swedish army troops being virtual full-time members of any United Nations force. At present the Swedes are operating under the United Nations flag in Cyprus and the Lebanon.



The 155-mm self-propelled gun – manufactured in Sweden – attracted worldwide interest when introduced in 1966. This heavy vehicle (over 50 tons) has a fully automatic gun which is fed from a 14-round clip, and which can fire a 48-kg (105-lb) HE projectile up to 25 km (15 miles).

The air force

Saab-Scania at Linköping has been the main supplier of combat aircraft to the Swedish air force (Flygvapen) for more than 40 years, and today has production lines building the JA 37 interceptor version of the canard-winged Viggen. This powerful combat aircraft is replacing the older Saab Draken in the fighter role, 161 of which remain in use, and 149 JA37s are being delivered.

In wartime, the Flygvapen would use airfields – of which about 45 have been built – and stretches of strengthened highway for dispersed operations. In such a situation for instance, a Viggen would land on a road, quickly taxi on a smaller road to a camouflaged shelter, be refuelled and rearmed in less than 10 minutes, and then taxi back to the road for take-off on another mission.

Attack and reconnaissance units have a further 180 AJ/SH37 Viggens armed with air-to-surface missiles for both anti-ship and anti-armour use, while specially developed cameras and infra-red equipment aid the recce units with the SF37 variant of this versatile aircraft. Light attack duties are flown by Saab Sk60Bs, and a trainer version equips the Ljungbyhed Flying Training School and the Air Force College at Uppsala. Fifty-eight British-built Bulldogs conduct basic training. A small transport unit is equipped with eight American Hercules and some ageing C-47s, the former being employed on United Nations work as well as supply duties within Sweden.

The navy

The Swedish navy is intended for local inshore defence only, and has no large deep water units. It is unusual in that as well as the seaborne element the navy also has a large and complex system of coastal defences involving radar, guns, guided missiles and prepared minefields, and it is the nature of these that has proved so attractive to marauding Soviet submarines in recent times.

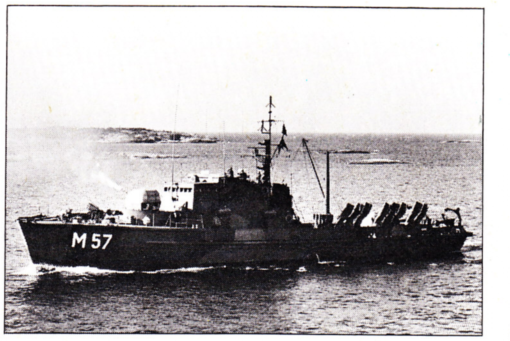
The coastal artillery could perhaps be dealt with first as it involves no less than five full regiments with 45 static batteries and 12 mobile batteries. The static batteries are currently in the process of being re-equipped with 75-mm and 120-mm turreted guns of advanced design with equally advanced fire-control systems, while the mobile batteries are being re-equipped with 120-mm *Karin* guns. Missiles include the RB-08 and the RB-52, both effective against even large naval craft.

Mines form an important part of Swedish coastal defences, so the navy includes a large number of minelayers for both inshore and deeper water use. From the larger sizes downwards the navy has two full-size minelayers and two training vessels for the role. To these can be added nine coastal and 36 inshore minelayers. For clearing there are 11 coastal and 20 in-shore mine-sweepers.

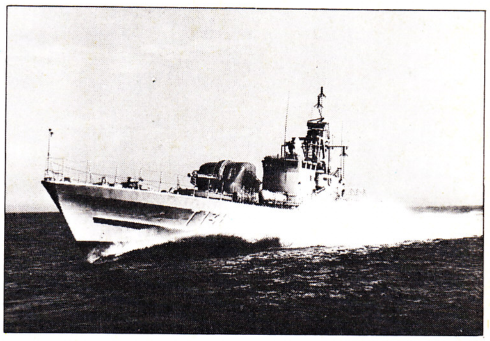
The main navy bases are at Stockholm, Karlskrona, Göteborg and Härnosand. These bases support the main defensive element of the navy, which has as its largest vessels two destroyers with RB-08 surface-to-surface missiles (only one of these is kept in service at any one time). A force of 12 submarines is used to provide an offensive patrol capability and a further four submarines are on order. A surface capability is provided by a force of 17 *Hugin* fast attack patrol craft armed with RB-12 *Penguin* surface-to-surface missiles, and to these can be added a further 18 torpedo-armed fast attack craft. A force of 33 coastal patrol craft back up this force and to these will be added a further four now on order.

The navy maintains two helicopter squadrons. One is at Berga, near Stockholm, and is equipped with four Alouette 11 trainers and 10 AB.206s that can be used in the anti-submarine warfare, commando transport or gunship roles. The other squadron is at Säve near Gothenburg and has 10 Boeing Vertol/Kawasaki KV-107-11 that are used in a wide variety of roles including anti-submarine warfare, search and rescue and long-range surveillance. They are also to be used to operate with the new RBS-15 anti-shipping missile that has been ordered for all Swedish navy vessels.

The navy has one further claim to being unusual: it maintains a large force of no less than 143 landing craft. Nine of these can be used as landing tanks and similar vehicles, but the bulk (81) are utility craft that can be used for a number of purposes. 53 are assault landing craft. All three types can be used to land troops in remote regions, possibly behind an attacker's front lines.



The Swedish navy devotes a relatively high proportion of its resources to mine warfare. The 300-ton minesweeper Arkö *is typical of its kind. Of wooden construction and armed with a 40-mm gun,* Arkö *was commissioned in 1958, the first of a 12-ship class.*



Norrköping *is a 'Spica'-class fast patrol boat, armed with a radar-directed 57-mm Bofors gun and six 21-inch torpedo tubes. The anti-ship capability of the 'Spicas' will be much enhanced by the installation of long range (70 km/44 miles) RBS 15 anti-ship missiles, currently under development.*

Saab Viggens of the Flygvapen fly low over the tundra landscape. The Viggen is the mainstay of Sweden's air defence force, and serves in the attack (AJ37), interceptor (JA37), overland reconnaissance (SP37), maritime reconnaissance (SH37) and trainer (SK37) roles.

Order of Battle

Army (on mobilization)
Five armoured brigades
One army aviation battalion
19 infantry brigades, including four Norrland brigades
50 independent infantry, artillery and anti-aircraft artillery battalions
26 Local Defence Districts encompassing 100 independent battalions, up to 500 independent companies and Home Guard units

The air force
Six attack squadrons (AJ37 Viggen and Saab 105)
12 fighter squadrons (JA37 Viggen and J35D/F Draken)
Six reconnaissance squadrons (SH37/SF37 Viggen)
Two operations conversion units (SK37 Viggen and SK35C Draken)
Two transport squadrons (C-130 Hercules, C-47 Dakota and Caravelle)
Five communications squadrons (Saab 105)
One search and rescue squadron (KV-107)
One utility helicopter squadron (Alouette II and Bell AB.204)

Navy
Two destroyers with RB-08 (one in reserve)
12 submarines (four under construction)
17 fast attack craft with RB-12 missiles (two under construction)
18 fast attack craft with torpedoes
34 coastal patrol craft (seven of them large, with four more on order)
Two minelayers
Two minelayer/training ships
Nine coastal minelayers
36 in-shore minelayers
11 coastal minesweepers
20 in-shore minesweepers
45 coastal batteries, static
12 coastal batteries, mobile
two helicopter squadrons